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BLOOD PRESSURE AND PULSE RATE CHANGES DURING THYROIDECTOMY

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DURING a thyroidectomy for a toxic goiter it is a universal observation that there is a rise in blood pressure and pulse rate due to the thyrotoxicosis in itself and not related to the anesthetic agent. Consequently, the value of routine blood pressure and pulse rate readings during a thyroidectomy is even greater than during other operative procedures. The character of the reaction may determine whether or not the operation is to be started, and, once started, if it is to be continued, terminated, or confined to a subtotal resection of one lobe. In order to evaluate a reaction during anesthesia one must first know what kind of a reaction one should expect in a patient with moderate and one with severe thyrotoxicosis. A cursory survey of a series of anesthetic charts on thyrotoxicoses showed certain constantly recurring patterns in the blood pressure and pulse rate curves. It has been our object to determine if these patterns could be definitely correlated with the degree of toxicity. In order to do this we have made a statistical analysis of the blood pressure and pulse rate readings during anesthesia in over 600 thyroidectomies on patients with varying degrees of thyrotoxicosis.

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METHOD OF APPROACH

Each clinical record was carefully analyzed to determine the type of goiter and the degree of toxicity at the time of operation. In order to make a uniform classification the preoperative dispensary record, the hospital record, the postoperative course, the pathological report, and the postoperative dispensary record were reviewed by the authors personally. This was done without reference to the anesthetic record. An average was made of the blood pressure and pulse readings taken on the ward. Likewise an average was made of the readings taken immediately preceding anesthesia. The induction of anesthesia was taken as the starting point in all cases. All the readings taken within the first 5 minutes were placed in the 5 minute column and averaged. Likewise the readings taken 10 minutes after the beginning of anesthesia were placed in the 10 minute column and averaged. The readings taken at subsequent 5 minute intervals were placed in their respective columns. The time interval between the beginning of anesthesia and the time of taking the blood pressure and pulse rate readings determined into what columns these readings fell. Obviously the duration of the operations varied, and the readings taken at a certain time interval do not always correspond to the same

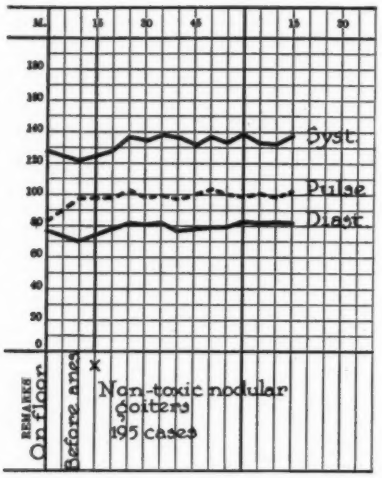

Chart 1. Average curves of blood pressure and pulse rate readings during thyroidectomy in 195 patients with uncomplicated, non-toxic nodular goiters.

state of the operative procedure. It was our aim to take readings at 5 minute intervals. All charts with only a few readings were discarded. In all cases in which there was hemorrhage, respiratory obstruction, cyanosis, or other technical complications the record was likewise discarded.

Premedication consisted of ¼ or ⅛ grain (.016 or 0.01 gram) of morphine sulphate and 1/150 grain (0.0004 gram) of atropine sulphate, given approximately 1 hour before operation. In more than half the cases this medication was preceded by 1½ grains (0.1 gram) to 3 grains of pentobarbital sodium at 6 o'clock in the morning of the operation. The anesthetic agent was ethylene in 90 per cent of the cases and nitrous oxide in the remaining 10 per cent. Cases in which the premedication was inadequate for nitrous oxide or ethylene anesthesia without cyanosis were excluded.

RELATIONSHIP TO TOXICITY

Non-toxic nodular goiter. The curves of the blood pressure and pulse rate readings during a thyroidectomy for non-toxic goiter offer a basis for comparing the effect of toxicity. We reviewed a series of records of patients with uncomplicated, non-toxic goiters. We accepted for this series only those patients who showed no evidence of thyrotoxicosis. Borderline cases were excluded. Because we wished to establish an accurate standard for comparison we were very careful in this series to exclude all patients with any complicating disease and all cases in which there were complicating factors during the operation due to the operative procedure in itself or due to technical difficulties in the administration of the anesthetic agent.

The average curves of blood pressure and pulse rate readings during thyroidectomy in 195 patients with uncomplicated, non-toxic, nodular goiters are shown in Chart 1. Immediately before the administration of the anesthetic agent the systolic and diastolic pressure are a trifle lower and the pulse rate a trifle higher than on the ward. During the first 10 minutes the systolic pressure rises from 15 to 20 millimeters of mercury and then is maintained at a fairly constant level 10 to 12 points above the reading on the ward. The diastolic pressure rises about 10 points and remains approximately 5 points higher than the ward reading. The pulse rate changes very little, averaging 100 beats a minute throughout the operation. Although this is a fairly standard pattern, many variations may occur from this as well as subsequent patterns. In order to determine the variations from these averages we made a statistical analysis in all instances as follows: The readings, for instance, of the systolic pressure taken 5 minutes after the beginning of anesthesia were arranged in a column in order of magnitude. If there are 100 such readings arranged in order of magnitude, the highest, at the top of the column, the lowest at the bottom, number 50 will give a mean for the entire group. We found that in no instance did this figure vary more than 2 or 3 points from the calculated averages. The variation between number 25 and number 75 will give the variation of the middle 50 per cent of all the readings. Arranging all our figures in this manner, we found that as regards the systolic pressures 25 per cent of the readings were within 10 millimeters above the average and 25 per cent fell within 10 millimeters below the average. This was a remarkably constant finding in every series.

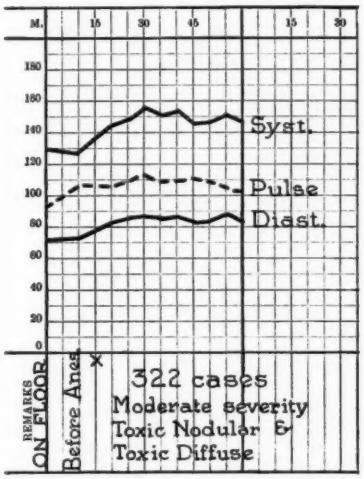

Chart 2. Findings in 322 thyroidectomies for thyrotoxicosis of moderate severity. These include patients with toxic nodular and toxic diffuse goiters.

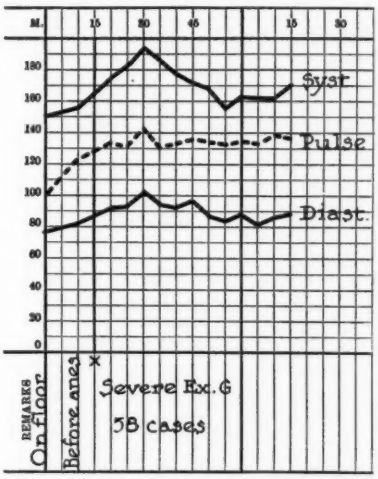

Chart. 3. Blood pressure and pulse readings of 58 patients during thyroidectomies for severe toxic, diffuse, and nodular goiters.

In this and all subsequent averages one can assume that 50 per cent of all systolic readings will fall within 10 points above or below the curves as shown. The diastolic pressures are not so variable, and in addition the variation above the average figure is greater than that below the average figure. Thus 25 per cent of the readings will be within 6 points above the average, and the other 25 per cent within only 4 points below the average. Roughly, however, one can assume that 50 per cent of all diastolic readings fall within 5 points above or below all the curves of average diastolic pressure. The pulse rate fluctuates more widely, and yet, with the exception of the severe toxic goiters, half of the total readings will be within 10 points above or below the average. In those patients with severe toxicosis the limits of the middle 50 per cent are 15 points on either side of the average figure.

Moderately toxic goiter (diffuse and nodular). We divided the thyroid cases showing toxicity into 2 main groups. The degree of toxicity was estimated for the time of operation only. Estimation of toxicity was based on the following factors: pulse rate, strength, duration of illness, amount and rapidity of weight loss, and basal metabolism rate.

Toxic manifestations at time of operation. Obviously even after all available data are considered it is impossible to divide the cases sharply into those presenting a moderate amount of thyrotoxicosis and those showing severe toxicity. If an individual entered the hospital presenting severe toxicity but under treatment showed marked improvement, he was included in the moderately toxic group. We were more interested in the degree of toxicity that the patient actually presented at the time of operation.

Chart 2 presents the findings in 322 thyroidectomies for thyrotoxicosis of moderate severity and includes the toxic nodular and the toxic diffuse goiters. As compared with the non-toxic group, the pattern as a whole is the same. The pulse rate is about 10 points higher. Again, the systolic blood pressure shows a slight fall and the pulse rate a rise in the operating room and preceding the induction of anesthesia. During the first 10 minutes the systolic pressure shows a sharper rise of 20 points and is maintained at about 150 millimeters during the operation. The diastolic pressure is again elevated about 10 points and maintained at that level. The average pulse rate varies only a few points from 110. Most observers are under the impression that,

on the whole, patients with toxic, diffuse goiters give a sharper reaction than those with toxic, nodular goiters. This is undoubtedly true, for in our group of 58 severe cases, 50 had toxic, diffuse goiters and only 8 had toxic, nodular goiters. Nevertheless, a goiter of the same degree of toxicity produces the same reaction during anesthesia whether it is diffuse or nodular. The average blood pressure and pulse rate curves for 146 toxic nodular and 174 toxic diffuse goiters, both of moderate severity, showed that these 2 are very nearly identical.

Severe toxic goiter (diffuse and nodular). There were 58 patients in this group (Chart 3). In order to establish a standard for comparison we placed all borderline cases in the moderately toxic group. As a result, of a total of over 300 toxic goiters we have only 58 that we considered severe. From a purely clinical viewpoint the number would be much larger; however, when one considers severity at the time of operation only, the number shrinks considerably.

When the patient is brought to the operating room floor, in contradistinction to the preceding groups, the systolic and diastolic pressures and pulse rate rise. After the operation is started there is a considerable additional rise in systolic pressure, reaching a peak in approximately 15 minutes and then gradually dropping. The diastolic pressure rises and falls in unison with the systolic but to a much less degree. This sharp rise in systolic pressure is quite characteristic of severe thyrotoxicosis. Its rise is roughly proportional to the degree of toxicity but in the absence of true hypertension it rarely goes much above 200. Although the initial rise can be attributed to an excitation of the thyrotoxicosis, the subsequent fall is more difficult to explain. Possibly the organism adjusts itself to the insult of the anesthesia and the operation. If the pressure is maintained at a high level or continues to rise, the situation is clearly less favorable. The pulse rate in this group is very high, averaging 130 in contrast with a rate of 110 in the moderately toxic and 100 in the non-toxic group. The pulse rate is more variable than the blood pressure; hence, as stated, one must allow a 15 point variation on either side of our average curve in order to include 50 per cent of all cases. At times the pulse rate is exceedingly rapid when the patient is placed on the operating table, then falls to a reasonable rate as soon as anesthesia is obtained. If a rapid rate does not subside, the operation probably should not be performed. An average pulse rate of 140 or above indicates a poor risk, and one above that should command considerable respect. Not infrequently an irregularity, usually an auricular fibrillation, may appear during the operation. Although this condition is by no means a source of comfort, its occurrence usually causes more alarm than subsequent events justify.

The diastolic pressure varies little and is of slight importance. Thyrotoxicosis has a tendency to lower the diastolic blood pressure. If the reaction during the operation were identical to the findings in clinically severe thyrotoxicosis, the diastolic pressure should have a tendency to drop; but this is not true. It was extremely uncommon to have an appreciable independent drop in the diastolic pressure; but when it did occur, it was always in a patient who was exceedingly ill. All that one can safely say is that a thyrotoxic patient is a sensitive individual who reacts sharply to any stress or strain and that the reaction is roughly proportional to the degree of toxicity and to the severity of the exciting factors.

LOCAL ANESTHESIA

The effect of local anesthesia was observed in a series of 25 thyroidectomies. The agent used was ½ per cent procaine solution without adrenalin. The cases which were considered in this series were uncomplicated and fell into the moderately toxic group and were composed of toxic, nodular and diffuse, parenchymatous goiters.

The average variation in systolic and diastolic blood pressure is slight, within 10 points of the reading on the ward. The pulse rate is maintained at a higher level, between 120 and 130 beats per minute throughout the operation. The pulse rate in the mildly toxic group under general anesthesia was 110. Only the very severe group under general anesthesia attained an average rate of 130 beats per minute.

The thyroidectomies on uncomplicated, non-toxic, nodular goiters were further grouped by age into decades. The maximum average pulse reading that occurred in any decade throughout the simple, non-toxic group was 108. Apparently the decade by decade group variation in blood pressure and pulse rate during thyroidectomy in the absence of toxicity or hypertension is small, but definitely present after the age of 40 years.

EFFECT OF HYPERTENSION

Thyrotoxicosis does not produce true hypertension; it elevates the systolic pressure but the diastolic pressure remains the same or, if anything, is moderately reduced. An elevated diastolic pressure is necessary for a diagnosis of essential hypertension. In the group of patients with hypertension we included only those who had a diastolic pressure of between 90 and 100 and a systolic pressure of over 190. Those with decompensated hearts, with albuminuria, or with auricular fibrillation were excluded.

It is a common notion that toxic nodular goiters have a tendency to cause hypertension. In any series of cases it will be found that more patients with a toxic nodular goiter have high blood pressure than those with a toxic diffuse goiter. This finding is due to the fact that the patients with toxic nodular goiters fall into a higher age group. If one compares the 2 types in patients of the same age group, he will find that the incidence of hypertension is the same. The increased frequency of heart complication in patients with toxic nodular goiters can be explained on the same basis. From a rough appraisal of our material it would appear that a decompensated heart as well as high blood pressure occurs in the older individuals regardless of whether they have a toxic nodular or a toxic diffuse goiter.

Chart 4 presents the average curves obtained for 28 patients with hypertension plus a thyrotoxicosis of moderate severity. There were 21 patients, of an average age of 50, with toxic nodular goiter, and only 7, of an average age of 43, with toxic diffuse goiter. The pattern is the same as for toxic goiter without hypertension except that the pressures are much higher.

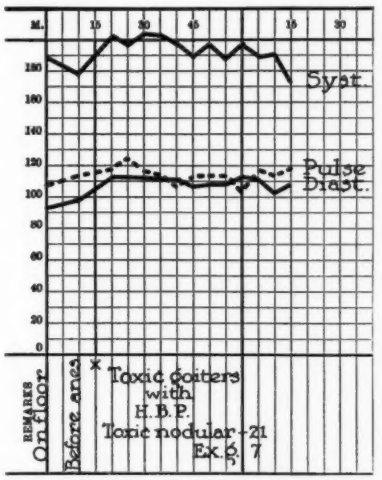

Chart 4. Average curves obtained for 28 patients with hypertension plus a moderately severe thyrotoxicosis.

Occasionally during anesthesia the blood pressure will be maintained at a high level in spite of the fact that the patient originally had neither a high diastolic pressure nor a severe degree of toxicity. We have tried to explain these charts on the basis of an unrecognized hypertension or a latent hypertension. Very often one will operate on a patient with toxic goiter with a blood pressure of, let us say, 180 systolic and 80 diastolic, and find to his surprise after the thyrotoxicosis has been controlled that the blood pressure is 200 systolic and 110 diastolic. When thyrotoxicosis develops in a patient with high blood pressure, the diastolic pressure drops an appreciable amount and is invariably elevated after the operation. In such an individual the hypertension could easily be overlooked.

EFFECT OF OXYGEN DEFICIENCY

Oxygen deficiency, breathing of excessive quantities of carbon dioxide, straining, and overventilation have distinct effects on ventilation and circulation. Schneider has compared the respiratory and circulatory effects of anoxemia and carbon dioxide. Low oxygen tension effects were produced in normal individuals by rebreathing 52 liters of air from which carbon dioxide had been removed. The carbon dioxide effects were produced by re-

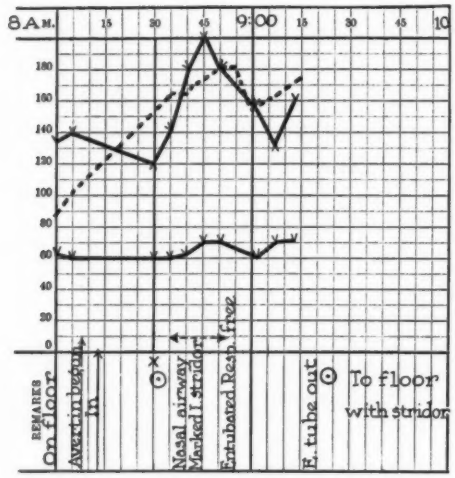

Chart 5. Effect of tracheal obstruction in the presence of thyrotoxicosis.

breathing air in which the oxygen content was maintained at 25 or 30 per cent while the carbon dioxide content gradually increased. Schneider's results are as follows:

	Anoxemia	Carbon dioxide
Average increase per min. vol.	5.6 liters	40.2 liters
Average depth of breathing	330 c.cm.	2,000 c.cm.
Rate of breathing	Slightly increased	Doubled
Acceleration of pulse	28.7 beats	12 beats
Rise of systolic pressure	15.8 mm. Hg.	21.6 mm. Hg.
Diastolic pressure	Rise 6.9 mm. Hg.	Fall 12.1 mm. Hg.
Rise in pulse pressure	22.9 mm. Hg.	10 mm. Hg.
Capillary pressure	No change	Rise 13 mm. Hg.
Venous pressure	Fall 4.3 cm. H_2O	Rise 4.7 cm. H_2O

These effects vary in degree in different individuals. A patient with thyrotoxicosis tolerates oxygen want less readily than a normal person; hence the changes due to anoxemia are exaggerated in the presence of thyrotoxicosis. It is obvious that a rise in blood pressure and pulse rate of considerable magnitude can occur from anoxemia alone. Indeed, it may be difficult at times to distinguish between the two. Thus if during the conduct of anesthesia in a thyrotoxic patient the curves of the systolic and diastolic pressures and the pulse rate rise, the anesthetist must make doubly sure that the rise is not due to anoxemia or carbon dioxide rather than thyrotoxicosis.

Chart 5 shows the effect of tracheal obstruction in the presence of thyrotoxicosis. The patient had a severe toxic diffuse goiter for which a subtotal resection of the right lobe had been performed 6 weeks previously. The right recurrent laryngeal nerve had been paralyzed at that time. In the course of the second operation the lower portion of the inferior thyroid artery was injured. As the bleeding was controlled a marked inspiratory strider developed. Sufficient oxygen was given under pressure to prevent cyanosis. The systolic blood pressure rose to 200, the pulse rate to 180. As the pressure began to fall and the pulse rate became poor in quality an endotracheal tube was inserted. The patient's condition improved almost instantly although the pulse rate remained very rapid. Tracheotomy was necessary upon removal of the endotracheal tube.

EFFECT OF HEMORRHAGE

An excessive loss of blood during a thyroidectomy produces the same circulatory changes as in any other operation (3). The slowed circulation and the loss of oxygen-carrying erthrocytes cause a decrease in the oxygen content of the blood although the percentage of carbon dioxide is not materially altered. These changes are related not so much to the actual quantity of blood lost or to the amount lost in relation to the body weight as they are to the rate of blood loss. If oxygen lack is continued too long the damage will be permanent.

It cannot be overemphasized that when the anesthesia record first indicates a loss of blood, danger is imminent. Pilchner has estimated an average loss of blood in thyroidectomies of 100 cubic centimeters and a maximum loss of 300 cubic centimeters. In a difficult operation a loss of 1,000 cubic centimeters is not impossible.

The effect of the loss of blood on the anesthesia record in a thyroidectomy is the same as in any other operation, i.e., a recession of the systolic and diastolic pressure accompanied by an increase in pulse rate (Chart 6).

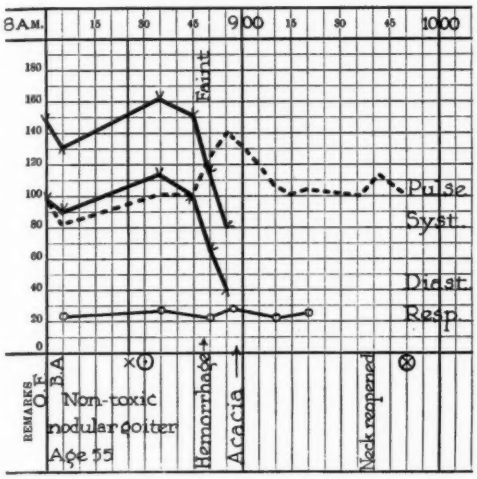

Chart 6. Graph showing recession of the systolic and diastolic pressure accompanied by an increase in pulse rate due to hemorrhage.

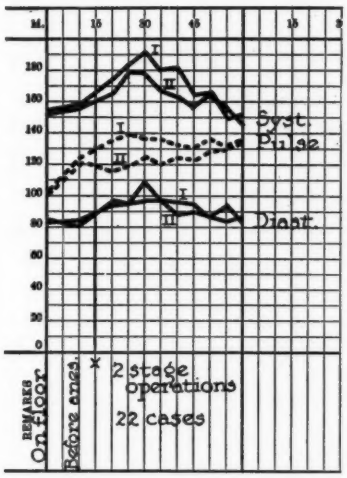

Chart 7. Averages computed in 22 patients suffering with severe toxic, diffuse goiters who had 2 stage operations.

There is this difference, however: In thyrotoxicosis, as has been shown, the systolic pressure rises as the pulse rate rises; consequently, if one finds a rise in pulse rate with even a stationary blood pressure, he can suspect excessive bleeding.

TWO STAGE OPERATIONS

A second stage operation offers an opportunity to compare the effect of the anesthetic agent and the operation on the same patient, who now presumably has a lesser degree of toxicity than in the first operation. We compared the averages of 22 patients (Chart 7) with severe toxic diffuse goiter who had 2 operations, a subtotal resection of the right lobe followed in approximately 6 weeks by a subtotal resection of the left lobe. At the time of the second operation it seemed that each patient showed some improvement, and yet in many it was difficult to demonstrate this definitely. Nearly all had a gain in weight; this was the most constant evidence of improvement. At the second operation the patient is still very sick although he is much less likely to die. It is apparent that the reaction during the second operation will be very similar to the reaction during the first operation, and that whatever improvement has been obtained is evidenced largely by a drop in the pulse rate.

DEATHS

It is the record of the patient who dies that in the final analysis forms the basis of judgment in evaluating the risk. By comparing the reaction during the operation with that after the operation in a large series of cases, one finds a definite correlation between the two. There are many exceptions: In some cases the reaction during operation is severe and the postoperative course is stormy. The judgment of risk based upon pre-operative clinical data is much more accurate than judgment based upon the behavior of the patient during the operation. This is as one would expect. It is more clearly seen when one analyzes the deaths. In the case of most patients who die, death results apparently from a postoperative exacerbation of the thyrotoxicosis, and the anesthesia chart shows evidence of severe toxicity. Yet it is possible to collect a series of charts showing a similar reaction during anesthesia in patients who not only did not die but who had a smooth recovery. Recovery from the operation depends to a much less degree upon the character of the reaction than it does upon the patient's ability to withstand the reaction. Neverthe-

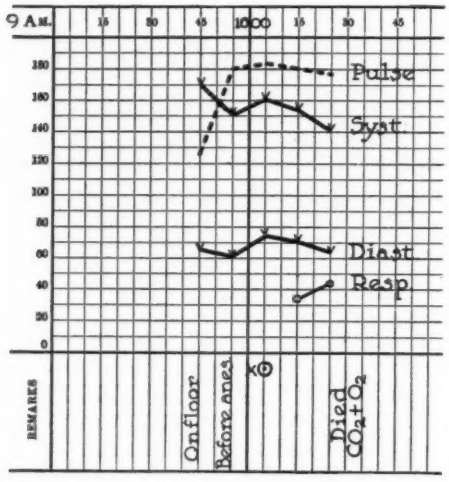

Chart 8. Pulse, blood pressure, respiration, Case 1.

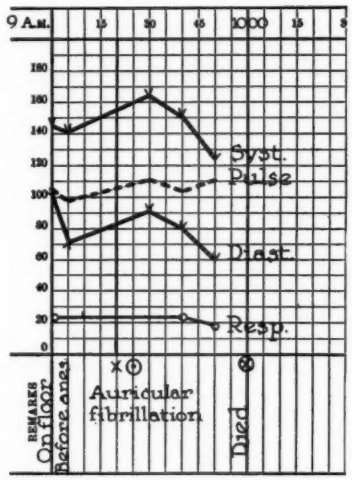

Chart 9. Pulse, blood pressure, respiration, Case 2.

less, there are operations during which the reaction indicates that it would be wise to terminate them immediately, regardless of the surgeon's confidence in the infallibility of his criteria of operability. Conversely, there are those in which a reaction of only moderate degree may influence the surgeon to do a one stage rather than a two stage operation.

What, then, is the reaction during operation of these patients who died? To answer this question we have gathered the deaths from this series of cases and included only those in which the deaths were due to a thyroid crisis.

CASE 1. A colored woman, 43 years old, had nervousness and goiter for 4 years, dyspnea, palpitation, and weakness for 2 years, and a loss of 51 pounds in weight during the past year (Chart 8). The basal metabolic rate was +76. The pulse rate was 120 to 130 and the blood pressure 170/66. The Wassermann reaction was 3; albuminura (1) was present. Moderate exophthalmos and a moderate degree of nervousness and tremor were present. The thyroid gland was diffusely enlarged to about three times its normal size; a bruit could be heard over each superior pole.

Ten drops of Lugol's solution was given 3 times a day for 4 weeks. The weight remained the same for this period. The patient was able to walk about but was rather weak.

The pulse rate was 176 before the anesthesia was started and remained at about that level during the operation. Both lobes were removed. While the wound was being closed the pulse suddenly became imperceptible, and as suddenly the patient died. The autopsy showed marked hyperplasia of the thymus, generalized lymphadenopathy, luetic aortitis, eccentric hypertrophy of the left heart, a congenital narrow aortic orifice, marked decrease of the lipoid content of the adrenals, and lymphoid hyperplasia of the gastro-intestinal tract.

When the pulse rate remains at 180 after the anesthesia has been started, it would be better to postpone the operation. If the pulse rate is maintained at that level, it is folly to remove both lobes. An exception occurs in children under 12 years of age, in whom the pulse is invariably so exceedingly rapid that one expects a rate of 160 to 180 beats per minute.

CASE 2. L. D., a woman, aged 39, developed a goiter and symptoms of thyrotoxicosis following the death of her husband 2 years previously (Chart 9). Rather suddenly she became very nervous and weak; the heart was rapid and irregular; the weight dropped from 170 to 110 pounds. Her feet began to swell and she became so short of breath that she was obliged to remain in bed for 3 months. For the past 3 months she had been much better. The thyroid gland was diffusely enlarged to about 3½ times its normal size. An exophthalmic stare was present. There were multiple fibroids of the uterus; the mass reached to the umbilicus. The heart was slightly enlarged and fibrillating; the pulse rate averaged about 90 beats a minute. The blood pressure was approximately 146/100. The basal metabolic rate 10 days prior to operation was +84, 7 days prior to operation, +70, and 2 days prior to operation, +56.

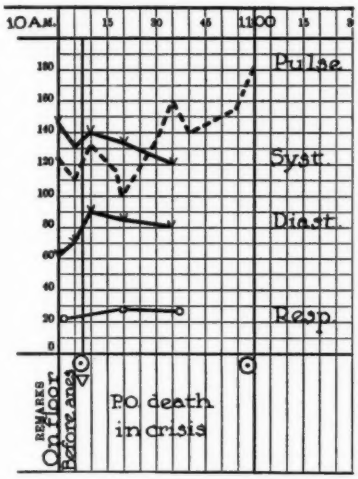

Chart 10. Pulse, blood pressure, respiration, Case 3.

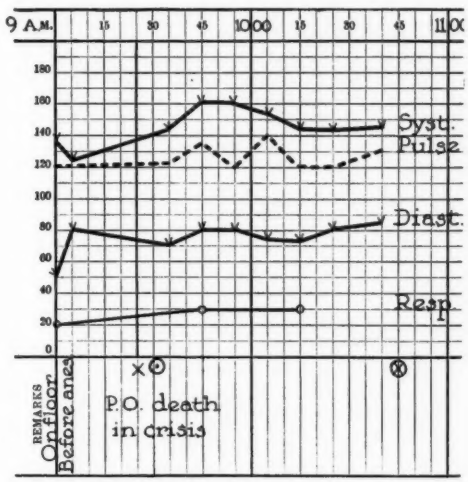

Chart 11. Pulse, blood pressure, respiration, Case 4.

The weight dropped 2 pounds during this time. This decrease was attributed to the loss of water in the edematous extremities. The patient was given Lugol's solution for 4 weeks and tincture of digitalis for 6 weeks.

The anesthetic chart is that of an uneventful operation. The chart is misleading in that the patient had a rapid auricular fibrillation making accurate observations of blood pressure and heart beat impossible. The course of both the operation and the anesthesia was uneventful until, at the end of the operation, very suddenly the patient's respirations became shallow, and almost immediately the pulse could not be felt in the wrist, cyanosis developed, the pupils dilated, and in a moment the patient was dead. The pathological diagnosis was toxic, nodular goiter. The autopsy showed chronic, myocardial fibrosis and degeneration, a myomatous uterus, right hydropelvis and hydro-ureter with pyelonephritis.

There is nothing in the anesthesia record to foretell such a catastrophe. It must be remembered, however, that the patient had an auricular fibrillation; in such a condition the pulse rate and the blood pressure readings are very inaccurate. With fibrillation it is well for the surgeon to feel the beat at the apex or along the carotid vessels during the course of the operation and compare the rate with the pulse in the peripheral vessels in order to assure himself that the pulse deficit has not reached an alarming figure. In this case the smoothness of the operation influenced the surgeon to complete the operation in 1 stage. In Case 1, the surgeon continued in spite of the warning signs. In both he was wrong.

CASE 3. S. P., a woman of 18 years had a goiter, nervousness, weakness, palpitation and dyspnea for the past 4 months (Chart 10). During that time she had lost 40 pounds in weight. A month ago she had an attack of nausea and vomiting. She had been taking 10 drops of Lugol's solution 3 times a day since the beginning of the symptoms without much improvement. The thyroid gland was diffusely enlarged and there was a moderate exophthalmos. She was in the hospital for 1 month. The basal metabolic rate rose from +44 to +49 and the weight dropped from 62 to 59 pounds. The pulse rate ranged from 100 to 120. The blood pressure was 146/100. Her strength improved so that she could be up and about out of bed, although she remained quite emaciated and very weak.

Lobectomy was performed under local infiltration anesthesia, a 0.5 per cent solution of procaine hydrochloride being used. During the operation the pulse rate rose until it became too rapid to count. Although the blood pressure usually rises with a rise in the pulse rate, in this case it dropped from 140 to 120 systolic. The loss of blood was larger than the average and may account for some of this fall. She left the operating room in poor condition. That night the blood pressure was 100/60, the temperature 102.2 degrees F. and the pulse rate 160. The patient seemed better. The temperature never rose above 101.2 degrees F. Toward evening she became much worse and died from acute thyrotoxicosis, at about the time most of such patients do die, that is, between 36 and 48 hours following the operation.

The pathological diagnosis was diffuse, parenchymatous goiter. No autopsy was performed.

From this case it can be seen that the pulse rate is a better index of the severity of the thyrotoxicosis than is the blood pressure.

CASE 4. E. B., a woman aged 17, had symptoms for 6 months (Chart 11). She lost 12 pounds in weight but gained them back. She was not very ill. The basal metabolic rate was +31. On the second day following a subtotal resection of both lobes, she became very ill, and died on the fourth day with a temperature of 108 degrees F. The goiter was of the toxic, diffuse variety. The autopsy showed a dependent congestion of both lungs, with early bronchopneumonia of the right lower lobe, hyperplasia of the thymus, and generalized abdominal lymphoid hyperplasia.

In this case neither the clinical history nor the course during operation gave the observer the slightest hint that this patient would die in a crisis. Although she did have some evidence of bronchopneumonia on postmortem examination, it was felt that death was caused by acute thyrotoxicosis.

SUMMARY

The blood pressure and pulse rate readings during thyroidectomy are analyzed in over 600 patients, with varying degrees of thyrotoxicosis.

An effort was made to correlate the changes during operation with the clinical picture. The readings were averaged in certain groups of cases and a composite chart of the averages was made as follows: The average curves in 195 cases of uncomplicated non-toxic goiter; the average curve in 322 cases of moderate severity; the average in 58 cases with severe thyrotoxicosis; the effect of hypertension on the anesthetic record; the effect of respiratory obstruction; the effect of hemorrhage; a comparison of the averages in the first and second stage of 22 cases with 2 stage operations; and the anesthetic records for 4 deaths during or following thyroidectomy.

There appears to be a direct relationship between the rise in blood pressure and the degree of toxicity at the time of operation. Although this reaction may be sharp, it is the pulse rate that gives the best index as to prognosis.

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ANESTHESIA AND ANOXEMIA IN RELATION TO THE USE OF NITROUS OXIDE

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RECENT medical literature has brought forth a wealth of articles dealing with the subject of untoward effects following nitrous oxide anesthesia. There is a difference of opinion regarding the etiology of these effects; some hold that anoxemia, or tissue anoxia, is responsible, while others maintain that when nitrous oxide is followed by undesirable effects, these are a manifestation of a toxic action of the nitrous oxide itself.

This subject deserves all the consideration and research which it is receiving at present, but it appears that certain important clinical points have been overlooked in the discussion. This is due to the fact that there have been certain errors present in the clinical use of this drug, and these errors have come to be looked upon as truths, through long usage, particularly by those with little or no clinical experience. It is unfortunate that this has been so, but it is a good sign when the laboratory worker interests himself in the subject, thus bringing to light certain clinical faults. Unfortunately, except in a few centers, anesthesia has received but little attention by competent and interested clinicians. In this country it has been the task of the nurse or junior interne, neither of whom has been able or willing to be more than a technician. Unfortunately, too, some recognized authorities have set forth the dictum that anoxemia during the administration of nitrous oxide is a normal and harmless condition (6). This has been thought to be true especially if the person administering the anesthetic agent has had a large number of previous asphyxiations to his credit. The weakness of this idea lies in the fact that the tissue cells do not know who is depriving them of their necessary oxygen, and thus suffer as much damage at the hands of the expert as of the novice. Undoubtedly a large amount of damage has been done by administering nitrous oxide without sufficient oxygen. This is because wrong methods have been used, and it should be recognized that the damage is due to anoxemia.

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In recent publications, Lowenberg and his associates have stated that nitrous oxide has toxic properties. A careful perusal of their case reports shows evidence, either direct or presumptive, of oxygen want in all the cases considered.

Either nitrous oxide is toxic or it is not. If toxic, it is possible that such toxicity becomes manifest only in case the patient is susceptible or in poor condition; if not toxic, the damage which is admitted must be due to the presence of some other factor. The purpose of this paper is to review the subject of nitrous oxide anesthesia from a clinical rather than a laboratory standpoint in an attempt to discover the fault.

PHARMACOLOGY OF NITROUS OXIDE

Although the work of Gianotti and Vannotti would seem to point to toxic properties inherent in nitrous oxide, it has been accepted by clinical anesthetists (Waters, etc.) that nitrous oxide is neither toxic, in the ordinary sense, nor is it irritating to the tissue. This is a very important question. We do know that this gas has a narcotic or anesthetic effect when inhaled. It is for this effect that the drug is given. There seems to be no evidence that patients have suffered ill effects when nitrous oxide has been given *in the presence of sufficient oxygen*. Greene and his associates state that beyond a certain point, the depth of anesthesia depends upon the oxygen want rather than upon the concentration of nitrous oxide. It is at the greater depths of so called nitrous oxide anesthesia that asphyxia enters the picture. Since it is necessary to produce different depths of anesthesia under different circumstances, we should evaluate nitrous oxide from a clinical standpoint and

place it in its proper niche among anesthetic agents as regards what may be called its potency. This brings us to a fact which is not sufficiently well known, namely, nitrous oxide is a very weak anesthetic. Although it will produce sleep in most patients, it does not possess the property of producing muscular relaxation. This lack of effectiveness is inherent in the drug itself, and is in no way due to the method of administration or the apparatus used. Since nitrous oxide produces otherwise a very pleasant anesthesia, attempts are constantly made to use it in cases in which muscular relaxation is necessary. These attempts must include the introduction of some other agent which will produce the necessary relaxation. In general, such adjuncts fall under 4 headings: (1) premedication; (2) local or regional block; (3) addition of other general anesthetic agents; inhalation, rectal, intravenous, and (4) addition of asphyxia. Note that asphyxia is spoken of as being added. It is not a normal part of anesthesia.

The habit of fortifying nitrous oxide anesthesia with some degree of asphyxia has become so common that most people regard it as a regular part of the picture. It is to eradicate this false and most dangerous belief that this communication is presented. It cannot be too strongly or clearly stated that *asphyxia should not be a normal accompaniment of nitrous oxide or any other anesthetic agent.* If it is present, either by accident or design, it is dangerous, and should not be allowed to persist under any consideration.

It follows, therefore, that if by the term, "surgical anesthesia," we mean a state in which muscular relaxation is present with adequate oxygen concentration, there is no such thing as surgical anesthesia produced by nitrous oxide and oxygen. The appreciation of this fact casts a new light on the statement of various authors in connection with untoward effects of so called nitrous oxide anesthesia. When Greene and his co-workers stated that the depth of anesthesia depends upon the oxygen content of the blood, they were right only up to a certain point. The added depth of anesthesia obtained with lower concentrations of oxygen was not anesthesia at all but a superimposed asphyxia.

Hewitt, in 1899, observed that various accompaniments of nitrous oxide anesthesia were due to oxygen want, and pointed out that these symptoms were not a part of true anesthesia. Brown, Lucas, and Henderson state that "patients anesthetized with nitrous oxide will always suffer from a severe degree of anoxemia, and this must impose a limitation upon its use and increase its danger." These authors also fall into the common error of assuming that surgical anesthesia is possible with nitrous oxide, and that asphyxia is a part of normal anesthesia.

It is true then that nitrous oxide, properly given, has very definite limitations as an anesthetic agent. This being the case, it follows that if muscular relaxation is present with nitrous oxide there must be more or less anoxemia. It is also true that we must have muscular relaxation to perform a laparotomy successfully. Therefore, any report of a laparotomy done under nitrous oxide anesthesia is also a report of a case of anoxemia. Bearing this in mind, it would seem that there is evidence that anoxemia was present in all the cases reported by those who have written on the damage done by nitrous oxide anesthesia. We certainly cannot disregard the possible effect of such anoxemia. I believe that Lowenberg and his associates have been in error in not recognizing this fact. Their pathological findings are above reproach, but they have not sufficiently considered the clinical data. This has led to the drawing of wrong conclusions.

A review of the subject of nitrous oxide as an anesthetic agent resolves itself into a consideration of the pharmacology of nitrous oxide and its properties as an anesthetic. Nitrous oxide is a relatively weak anesthetic, therefore, its use must be confined to those cases in which muscular relaxation is not desired, or to produce sleep only in cases in which relaxation has been produced by other means.

If the limitations of nitrous oxide are understood and too much is not expected of it, it takes its proper place in the armamentarium of the anesthetist. Its use is indicated in operations not involving muscular structures.

If nitrous oxide is given with sufficient oxy-

gen, it can be given safely for any length of time and to patients of any age. It was formerly believed that its use was unsafe in the case of children. Any ill effects following its use in this class of patients has been due to the fact that children are more susceptible to anoxemia than adults. If anoxemia is avoided, this objection disappears.

Nitrous oxide has also been said to be suitable only for short operations. This is also a mistake. Naturally, an hour of anoxemia is more dangerous than 5 minutes. If the anoxemia is avoided, nitrous oxide anesthesia may be maintained as long as necessary.

The use of nitrous oxide in obstetrics should receive special mention. It has been suggested that this drug was a possible factor in the production of cerebral damage in the newborn. The recent studies of Schreiber and Gates would seem to place the fault elsewhere and to confirm the belief that nitrous oxide itself is harmless, provided sufficient oxygen is given with it.

Anoxemia has long been known as a dangerous condition. Nitrous oxide, on the other hand, has long enjoyed a reputation of harmlessness. When both are shown to have been present and damage has resulted, it seems unreasonable to blame the nitrous oxide without first proving beyond doubt that the more obviously dangerous anoxemia has had no ill effects.

The abandonment of the secondary saturation technique, the promiscuous use of nitrous oxide by unskilled attendants and others in dental offices, and the "pushing" of nitrous oxide in surgical cases, will soon prove that asphyxia not anesthesia with nitrous oxide is responsible for the untoward effects which recently have been receiving attention.

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DISTURBANCES IN THE CIRCULATION AND RESPIRATION IN OBSTRUCTION OF THE BLOOD FLOW TO AND FROM THE HEART

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THE surgical treatment of various diseases of the thorax has made rapid advances during the past two decades, and at the present time thoracic surgery enjoys a wide scope of application. Not only has the mortality and morbidity of certain diseases been drastically reduced but still other conditions, formerly thought to be incurable, are now found to be amenable to surgical therapy.

Factors responsible for this advancement include a thorough understanding of the cardiorespiratory physiology under normal conditions and its variation with disturbance of intrathoracic pressures. It is only natural that as more pathological processes were attacked, the problems to be solved became more instead of less complex, and at present many obstacles still remain. Of these, obstruction of the superior vena cava by tumor, thrombosis, infection, or mediastinal emphysema; occlusion of the pulmonary arteries by emboli; valvular stenosis and insufficiency, and acute cardiac embarrassment by tamponage, comprise only a few. In order better to understand the fundamental derangement of the normal physiology brought about by these pathological entities, an attempt was made to assimilate the conditions in experimental animals by obstruction of the large vessels leading to and from the heart.

EXPERIMENTAL METHOD

Only normal healthy dogs were used and were given a pre-operative dose of ½ to 1 grain of morphine. The experiments were of an acute nature, i.e. the animal was not allowed to live after the experiment ended. Intratracheal insufflation ether anesthesia was employed. Occlusion of the superior and inferior venæ cavæ individually and together, of the main pulmonary artery alone and of its branches individually and together, of the aorta alone or in combination with occlusion of the main pulmonary artery, were carried out.

The arterial pressure was obtained from the carotid artery in the usual manner and recorded by a kymograph. The venous pressure was obtained from the external jugular vein in the neck, the cannula being directed centrally in order to record the variations of pressure coming from the right heart. The left auricular pressure was obtained from the left inferior pulmonary vein. A long cannula was used in order to reach the auricle and was maintained in position by means of a ligature. The tube which connected the cannula with the mercury manometer was passed through a stab wound in the left sixth intercostal space and the pressure was recorded by the kymograph. A tracing of the respiratory movements was obtained by means of a tambor connected with a bellows which was secured around the body of the animal at the level of the tenth intercostal space.

EXPERIMENTS

Group 1. Obstruction of the aorta (arch) in 3 dogs. The carotid and jugular pressures were obtained as described. The chest was opened through the left fifth intercostal space. The auricular pressure and the respiratory curve were recorded with the described technique. The aorta was isolated and occluded immediately outside of the pericardium proximal to the innominate artery.

Protocol 1, dog 646. Aortic occlusion for 6½ minutes with recovery of only respiratory movements following cardiac massage (Fig. 1).

Positive pressure intratracheal ether anesthesia was used and the chest was opened through the

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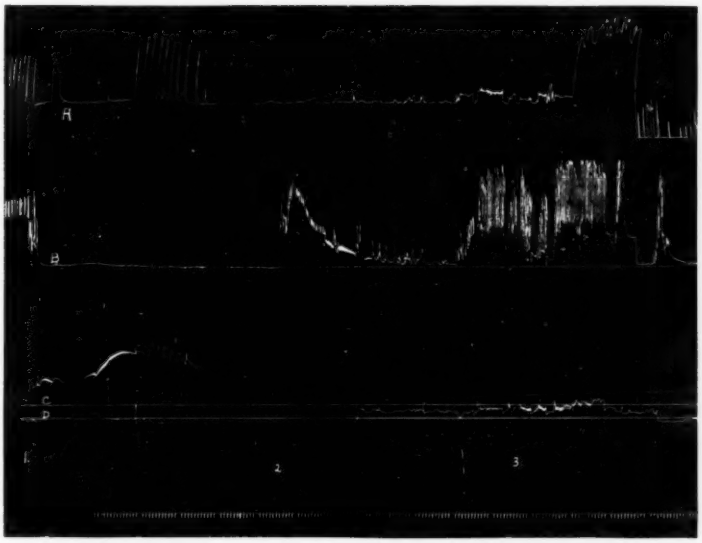

Fig. 1. Dog 646. Obstruction of aorta for 6½ minutes. Note: A, Respiration; B, carotid; C, left auricle; D, jugular; 1, obstruction of aorta; 2, release of obstruction; 3, cardiac massage. There was spontaneous recovery of respiratory effort although irregular in frequency and force. No cardiac recovery with massage of the heart.

fifth left interspace. The aorta was isolated and occluded with a soft clamp. The carotid pressure fell acutely to almost 0. There was spontaneous recovery on release of the obstruction 6½ minutes later but the carotid pressure again fell to almost 0 within 3 minutes. The jugular pressure presented a delayed rise of a few millimeters. The auricular pressure showed a progressive rise to 44 millimeters of mercury. The contractions of the auricles were still present 4½ minutes after the occlusion and the auricular pressure remained high during the entire obstructive period. The respiratory movements ceased during the first 2 minutes, then reappeared for 2 minutes and were of good amplitude. They stopped completely after 4½ minutes of aortic occlusion. Following release of the occlusion, massage of the heart gave rise to spontaneous respiratory movements 12 minutes after the last previous respiratory effort, but no cardiac response was noted. The occlusion was maintained for 6½ minutes.

The other dogs in this group showed records similar to the one just described.

Figure 2, dog 558, illustrates an example of aortic occlusion for 2 minutes. The carotid pressure exhibited a sudden sustained fall to a very low level with just as rapid return to a higher level as before, on release of the obstruction. A rapid secondary fall and return was a characteristic carotid pressure reaction in obstruction of the aorta. The jugular pressure showed an immediate rise to 20 millimeters of mercury, then a fall to the original level. At this time no more pulsations were seen in the jugular curve (respiratory movements) whereas the auricular curve (left auricle) showed regular contractions. The auricular pressure presented a sustained rise of 20 millimeters of mercury.

This is a typical example of recovery after a short period (1½ minutes) of occlusion of the aorta.

Group 2. Pulmonary artery obstruction in 10 dogs. The pressures were taken, as heretofore mentioned. The left chest was opened through the fifth left interspace. An incision was made in the pericardium; the main pulmonary artery was isolated from the aorta and was completely obstructed with a soft clamp.

Protocol 2, dog 558. Pulmonary artery obstruction for 1 and 1½ minute periods with recovery (see Fig. 3).

The carotid pressure showed a sudden sustained fall to about 20 millimeters of mercury. On release of the obstruction a fairly rapid return to normal within ½ to 1 minute occurred. The jugular pressure presented a delayed rise of only a few millimeters with a somewhat gradual return to normal

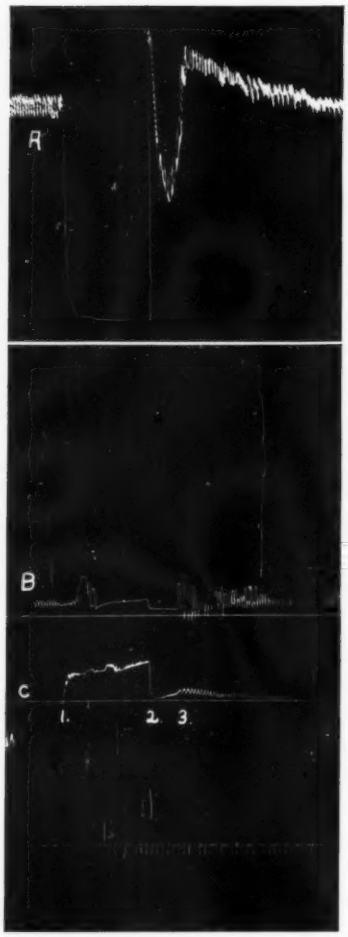

Fig. 2. Dog 558. Obstruction of aorta for 1½ minutes. Note: A, Carotid; B, jugular; C, left auricle; 1, obstruction of aorta; 2, obstruction released; 3, resumption of respiration, gasping in character.

after release of the obstruction. The auricular pressure was little affected. The pulsation became weaker but continued during the obstructive period. The respiratory movements as reflected in the jugular and auricular tracings became irregular in rhythm, rate, and force, and ceased entirely during the second period. This protocol is quite representative of this group of dogs. The tracing of the respiratory movements of dog 647 revealed marked irregularity and slowing during the 3½ minutes of obstruction followed by spontaneous recovery, although some irregularity was present. There was

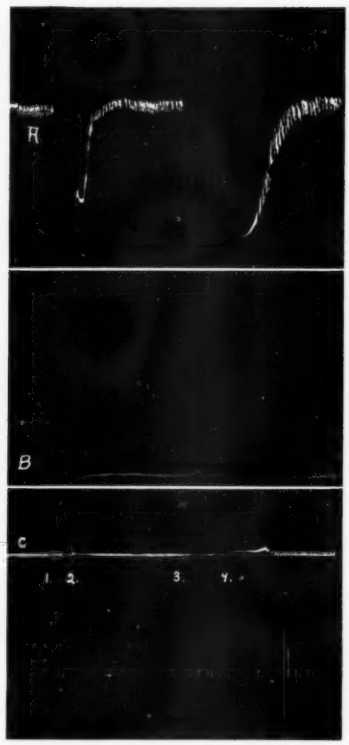

Fig. 3. Dog 558. Obstruction of pulmonary artery. Note: A, Carotid; B, jugular; C, left auricle; 1, obstruction; 2, release; 3, obstruction; 4, release. The respiratory action is reflected in both jugular and auricular tracings

spontaneous recovery of the respiratory effort in another dog following 6½ minutes of obstruction (Fig. 4, dog 648).

In these 2 two dogs, although there was spontaneous recovery of respiratory movements, in neither one could normal cardiac activity be restored by massaging the heart.

In 4 of 10 animals the effect of occlusion of the right and left pulmonary arteries individually *with the left chest open* was studied. This was done before and after the insertion of a cannula into a left pulmonary vein for recording the auricular pressure.

Figure 5, dog 615 reveals the changes observed when the left pulmonary artery was occluded. Practically no change in the carotid pressure was noted, 1–2. When the right pulmonary artery was obstructed, 3–4, the carotid pressure was lowered

about 8 millimeters of mercury. When, after having occluded the right pulmonary artery, a left pulmonary vein was obstructed, 6, the carotid pressure fell still further due to the added resistance to the blood flow.

As was expected, the changes in the jugular and auricular pressures and the respiratory movements were the same as in occlusion of the primary pulmonary artery.

Group 3. Obstruction of the pulmonary artery and aorta (together) in 6 dogs. The various pressures were obtained as herein described. The approach was made through the left fifth intercostal space. The obstruction of both vessels was accomplished with a soft clamp inside of the pericardial sac through an opening made over the region of the left auricular appendage.

Protocol 3, dog 957. Aorta and pulmonary artery obstruction for 2 and 2½ minute periods with complete spontaneous cardiac and respiratory recovery (see Fig. 6).

The carotid pressure showed an immediate fall to 30 millimeters of mercury with a gradual return to 130 millimeters of mercury (the pre-occlusion pressure) on release of the obstruction. The jugular pressure gradually increased to 12 millimeters of mercury which was fairly well sustained until the obstruction was released. The pulsations of the right auricle and the respiratory movements are recorded in the jugular tracing. In 2 periods of 2 and 2½ minutes of obstruction, the left auricular tracing showed a very sharp rise in pressure of 46 and 20 millimeters of mercury respectively, with a rapid fall to minus 6 within 1½ minutes, remaining negative until the obstruction was released. Pulsations of the auricle and respiratory movements are both recorded in the left auricular tracing, the former being present only a part of the time. The respiratory movements remained fairly regular during the first 2 minutes of obstruction; they gradually became slower and somewhat irregular, but became normal spontaneously on release of the obstruction. After 5 minutes of obstruction, massage of the heart stimulated no cardiac activity, but the respiratory movements returned again spontaneously.

The other dogs in this group produced very similar pressure tracings.

Group 4. Obstruction of venæ cavæ in 12 dogs. The various pressures were recorded in the usual manner. In most cases the approach was made through the right fifth intercostal space, in others through the left fifth intercostal space, and the venæ cavæ were reached through an opening in the mediastinum. The superior and inferior venæ cavæ were occluded individually and simultaneously. The vena azygos was also obstructed.

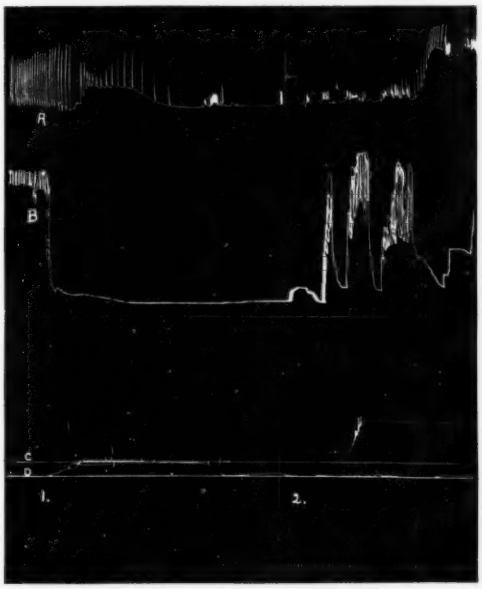

Fig. 4. Dog 648. Obstruction of pulmonary artery for 6½ minutes with spontaneous recovery of respiration but no recovery of cardiac action with cardiac massage. Note: A, Respiration; B, carotid; C, left auricle; D, jugular; 1, obstruction; 2, release.

Protocol 4, dog 82. Complete vena caval obstruction for 70 seconds (Fig. 7).

The right pleural cavity was opened through the seventh right interspace. The azygos vein was ligated. Little change in blood pressure was noted. The superior and inferior venæ cavæ were clamped simultaneously. There was an immediate sustained fall of the carotid pressure to 10 millimeters of mercury, and 70 seconds later an immediate return to the pre-occlusion level on release of the obstruction. The jugular pressure gradually rose to 22 millimeters of mercury and returned to a normal level immediately after release of the obstruction. The auricular pressure fell 6 millimeters of mercury below its previous value and after release showed a sudden rise, reaching 6 millimeters of mercury above its pre-obstructive level, followed by a gradual return to normal.

The effect of vena caval obstruction on respiration was well illustrated in dog 640 (Fig. 8).

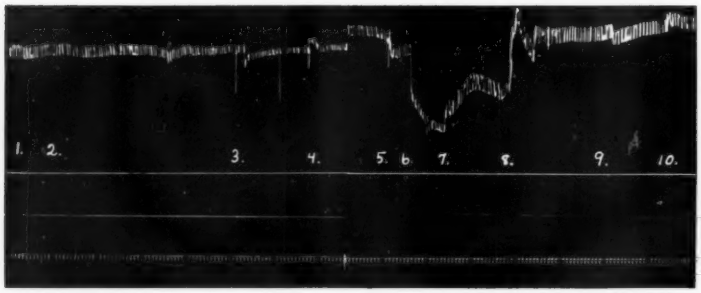

Fig. 5. Dog 615. Obstruction of the right and left pulmonary artery individually; obstruction of left inferior pulmonary vein with left chest open. Note: 1, Occlusion of left pulmonary artery; 2, release of same; 3, occlusion of right pulmonary artery; 4, release of same; 5, occlusion of right pulmonary artery; 6, obstruction of left inferior pulmonary vein; 7, release of vein; 8, release of artery; 9, occlusion of left inferior pulmonary vein; 10, release of vein.

The respiratory movements became gradually slower, were irregular in rhythm and force, and ceased entirely after 4½ minutes of obstruction. On release after 7½ minutes of occlusion there was spontaneous recovery of respiratory function. (The heart continued to beat regularly throughout this period.) After 1½ minutes of obstruction of the venæ cavæ, the aorta was momentarily obstructed and the superior vena cava momentarily opened allowing a little blood to go to the heart (Fig. 8, dog 640 1–2, 6).

Fig. 6. Dog 957. Occlusion of pulmonary artery and aorta for 2 and 2½ minute periods with recovery. A, respiration; B, carotid; C, left auricle; D, jugular; 1, occlusion; 2, release; 3, occlusion; 4, release.

Recovery of respiratory function was noted in some animals after release of obstruction of the venæ cavæ, lasting as long as 10 minutes, although during the first 3 minutes after release of the clamp, artificial respiration and massage of the heart was instituted (dog 650).

In order to determine the relative influence on the pressure changes observed, each vena cava was occluded individually (dog 398). The occlusion of the superior vena cava was accompanied by a fall of about 33 per cent in the carotid pressure (Fig. 9, A, 1), whereas a fall of about 60 per cent was observed when the inferior vena cava was obstructed (Fig. 9, A, 2). Figure 9, B and C, illustrate the effect of occlusion of one vena cava following the other, beginning with the vena cava superior in B (Fig. 9), and with the inferior in C (Fig. 9).

Other phenomena observed included the heart which became smaller in size, but the impulse was regular for as long as 7 minutes of obstruction. The lungs decreased in size and became pale. With the release of the obstruction, if recovery did not take place, the most outstanding finding was a marked dilatation of the right auricle. After observing these phenomena, instead of releasing both vessels simultaneously, we first released only the superior vena cava and after 2 to 3 minutes the clamp on the inferior vena cava was removed. The heart tolerated release of obstruction of the venæ cavæ individually better than simultaneously.

ANALYSIS OF EXPERIMENTS

When these experiments were begun, a more abrupt fall in the carotid pressure was anticipated in obstruction of the aorta than in obstruction of the other vessels. However, the carotid pressure fall was found to be similar in obstruction of all vessels entering or leaving the right or left heart. The recovery period on the other hand, exhibited a characteristic carotid pressure curve for the various vessels obstructed. With release of obstruction of the pulmonary artery, recovery of carotid pressure was quite gradual, whereas release of obstruction to the venæ cavæ or aorta resulted in a rapid return of carotid pressure to its original level. This can best be explained by the rapid tiring of the right heart muscle due to increased strain and dilatation during pulmonary artery obstruction. The left heart muscle on the other hand was not weakened to the same degree by the same period of obstruction of the aorta. In obstruction of the venæ cavæ the heart continued to beat but against greatly decreased pressure and could be compared to a motor running idle.

From the individual occlusion of the right or left pulmonary artery one learned that this type of obstruction decreased very slightly the arterial pressure and was perfectly tolerated. With the left chest open the carotid pressure varied following the occlusion of the left or the right pulmonary artery. The occlusion of the left pulmonary artery scarcely modified the blood pressure whereas obstruction of the right pulmonary artery resulted in a definite reduction in carotid pressure. This suggested strongly that the blood flow through the partially deflated lobes had been diminished.

In order to measure the auricular pressure a cannula was inserted into a left pulmonary vein since we wanted to know the effect of its occlusion upon the blood pressure. We not only observed that its occlusion diminished by 6 millimeters of mercury the carotid pressure but that when the right pulmonary artery was closed the obstruction of this vein produced a fall of 60 millimeters of mercury in the arterial pressure. This was explained by the fact that the entire blood stream had been diverted through the partially deflated left lung.

Fig. 7. Dog 82. Obstruction of both venæ cavæ and azygos vein. A, Carotid; B, jugular; C, left auricle; 1, occlusion; 2, release.

A sudden fall in the carotid pressure was unexpected in vena caval obstruction since it is reasonable to assume that the blood contained within the lesser circulation would be a source of supply for the general circulation for the period immediately following obstruction.

In every type of obstruction the jugular pressure was increased, reaching levels from 10 to 15 millimeters of mercury in obstruction of aorta, pulmonary artery, or aorta and pulmonary artery together. The pressure was elevated still more with obstruction of the venæ cavæ, reaching from 20 to 40 millimeters of mercury. In the case of operation for pulmonary embolism Kiser advises obstruction of the circulation on the venous side of the heart. He states that this should be better tolerated than obstruction on the arterial side,

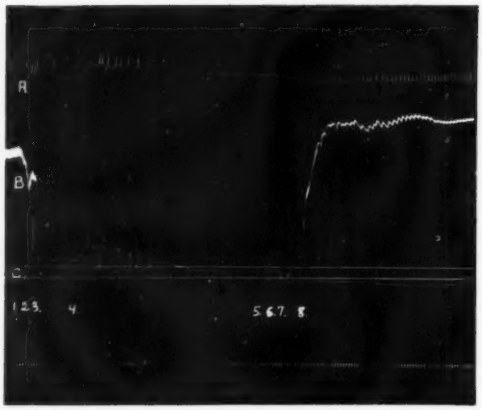

Fig. 8. Dog 640. Obstruction of both venæ cavæ and azygos for 8 minutes with spontaneous recovery of cardiac and respiratory function. 1, Occlusion of superior vena cava; 2, occlusion of azygos; 3, occlusion of inferior vena cava; 4, occlusion of aorta and momentary opening of superior vena cava; 5, release of aorta; 6, release of superior vena cava; 7, release of azygos; 8, release of inferior vena cava.

because the retention of venous blood in the brain during the period of interruption of circulation would have a prolonged nourishing effect. We found, however, that in obstruction of the aorta, pulmonary artery, or aorta and pulmonary artery together, there is enough back pressure and sufficient passive congestion to insure the brain against early ischemic changes. These experiments support a different reason for occluding the venæ cavæ in the operation for pulmonary embolectomy, i.e. that the heart (especially the right) is relieved of the increased strain due to the embolic obstruction and in itself adds no more load to cardiac activity.

It was interesting to see how quickly the obstruction of the aorta influenced the jugular pressure in spite of having to transmit its changes through the pulmonary circulation (Fig. 2B). As in pulmonary artery obstruction, occlusion of the aorta was followed by spontaneous recovery of respiratory movements more frequently than by cardiac activity.

The rise in the jugular pressure in cases of pulmonary artery obstruction was more delayed than was expected (dog 648) especially when one considers the sudden rise after occlusion of the aorta or of the pulmonary artery and aorta. Furthermore, the increased pressure did not last as long as the obstruction and after 4½ minutes fell to its initial level (dog 648).

The jugular pressure may reach higher values than those described in the protocol; e.g. instead of 22 millimeters of mercury noted in the protocol, the jugular pressure showed a rise of 40 millimeters of mercury in dog 589.

Auricular pressure. In obstruction of the venæ cavæ and in obstruction of the pulmonary artery a similar type of auricular pressure tracing was noted. This consisted of a rapid fall and an acute recovery with values above the normal during the first minute. The initial high elevation of the left auricular pressure with obstruction of the pulmonary artery and the aorta together, in comparison to that seen in obstruction of the venæ cavæ or pulmonary artery alone, could be accounted for by the effects of added occlusion of the aorta. However, the pressure rapidly returned to below the pre-occlusion level. That the auricle has not suffered a great deal with this type of obstruction (vena caval) is demonstrated by the good recovery. On the contrary, obstruction of the aorta was accompanied by an enormous increase in the auricular pressure. In spite of this the left auricular contractions lasted during 4½ minutes of obstruction. In the same dog the contraction of the right auricle recorded in the jugular tracing, ceased after 2 minutes of obstruction (dog 646) Fig. 1C. The left auricle seemed to maintain its power longer than the right even in this case in which the strain was exerted upon the left side of the heart. In no type of obstruction in which the back pressure affected the right heart have contractions of the right auricle been recorded in the jugular readings after 2½ minutes of obstruction.

As a general rule respiratory movements ceased after 3 or 4 minutes of obstruction of any of the vessels mentioned. In all cases they became irregular in force, rate, and rhythm, and finally ceased altogether. Spontaneous recovery took place after periods of 6 or 6½ minutes of obstruction. Artificial respiration, by increasing or decreasing the back pressure

Fig. 9. Dog 398. Obstruction of venæ cavæ individually and together. A, 1, Obstruction and release of superior vena cava; A, 2, obstruction and release of inferior vena cava; B, 1, obstruction of superior vena cava; B, 2, obstruction of inferior vena cava; B, 3, gasping respiration; B, 4, release of both venæ cavæ. Respiratory curve reflected in carotid tracing. C, 1, Obstruction of inferior vena cava; C, 2, obstruction of superior vena cava; C, 3, gasping respiration; C, 4, release of superior vena cava; C, 5, release of inferior vena cava.

in the intratracheal anesthesia apparatus, helped a great deal in aiding recovery of respiration when the periods of obstruction were prolonged to 7, 7½, or 9 minutes (obstruction of the venæ cavæ). Except in obstruction of the venæ cavæ, spontaneous recovery of respiratory function was much more frequent than spontaneous resumption of cardiac activity.

CLINICAL APPLICATION

It was interesting to learn that the heart would continue to beat regularly for periods of 6 or 7 minutes with complete obstruction of the entrance to the right heart. The almost bloodless field during this period greatly facilitates the performance of a number of cardiac operations such as suturing of wounds, removal of foreign bodies, and production or treatment of valvular lesions. This period could be prolonged by momentarily releasing the venæ cavæ and allowing a little blood to flow into the heart substantiating the results of Nystroem and Blalock. This blood probably irrigates the coronary circulation, thus strengthening the cardiac muscle. By this technique a recovery was obtained after a period of 9 minutes' obstruction in one dog and 7½ minutes in another (Fig. 8). Five minutes of complete obstruction was always well tolerated and was followed by spontaneous recovery.

On reviewing records of pulmonary artery and aorta obstruction together, we found no variations of the curve of the protocol given. By comparing the auricular and jugular curves one notes that the left heart does not suffer as much as the right in this type of obstruction. Although showing an acute rise, the pressure in the left auricle rapidly decreased below its initial level, whereas the pressure in the right auricle represented by the jugular curve remained elevated. As far as the heart was concerned the occlusion of both pulmonary artery and aorta was more like obstruction of the pulmonary artery than like obstruction of the aorta. The right heart had to support the same burden as in the occlusion of the pulmonary artery whereas the left heart, in spite of the aortic occlusion did not suffer dilatation, because, as demonstrated by the left auricular tracing, less blood came from the lungs. Furthermore, it is well known that the left heart is stronger than the right. At any rate the ill effect of occlusion of the pulmonary artery and aorta did not appear to be worse than obstruction of the pulmonary artery alone. This belief is contrary to the conclusions of Nystroem and Blalock. Thus in the operation for pulmonary embolism, if the pulmonary artery is to be occluded, including the aorta in the clamp would be tolerated just as easily by the heart. Since aortic occlusion is tolerated much better than pulmonary obstruction, a rational basis for occlusion of the aorta, alone, allowing the pulmonary artery to bleed freely, as practiced by Craaford in his later operations, is shown.

Disturbances in circulation and respiration following the interruption of the blood flow through the great vessels is not infrequently observed in clinical cases. The pres-

sure in the venæ cavæ being low, any considerable alteration of the intrathoracic pressures may interfere with the return flow of blood to the heart. The air of a tension pneumothorax, the fluid of extensive empyema, a chest wall or pleural tumor in the right side may compress the venæ cavæ. The same mechanism may take place in tumors, infection, scars or emphysema of the mediastinum. Acute and chronic compressive heart disease prevents adequate filling of the right heart which in turn is reflected in the circulation. Thrombosis of the venæ cavæ obstructs the circulation from within. Surgery of the great vessels and of the heart has not as yet reached its final stage of advancement.

As afore mentioned, the fact that regular cardiac contractions continue during 7 minutes of obstruction of the venæ cavæ, suggests that this procedure would facilitate the performance of a number of cardiac and intracardiac operations. In regard to pulmonary embolism, this study reveals that obstruction of one of the branches of the pulmonary artery is not accompanied by great disturbances of the arterial pressure. Furthermore, that during the Trendelenburg operation, constriction of the pulmonary artery and aorta will produce a failure of the right heart. Finally it was demonstrated that obstruction of the circulation through the venæ cavæ provided the longest safe period for the removal of pulmonary emboli during interruption of the blood flow through the heart.

SUMMARY

Obstruction of the blood flow through vessels leading to or from the heart was produced in dogs. The resultant variations in cardiocirculatory and respiratory physiology simulated very closely those usually associated with certain clinic conditions. Of the large blood vessels connected with the heart, obstruction of the venæ cavæ and azygos were by far the best tolerated. Cardiac activity remained regular for as long as 9 minutes with complete cessation of blood flow to the right heart. Obstruction of the pulmonary artery was tolerated the poorest of that of all the great vessels of the heart, presumably because of the opposite factor, that is, in vena caval obstruction the cardiac muscle is put somewhat at rest whereas in obstruction of the pulmonary artery the right heart burden is greatly increased. The practical application of these findings to clinical problems in thoracic surgery is discussed.

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THE EFFECT OF PROLONGED LOCAL ANESTHESIA IN OIL ON ABDOMINAL WOUND HEALING

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THE use of prolonged anesthesia in oil in abdominal operations seems logical in the light of our clinical experience with this type of anesthesia in other locations. This would seem to be particularly useful in operations involving the upper abdomen, in which it would be most advantageous to reduce or eliminate incisional pain, prevent abdominal wall and diaphragmatic splinting, and thus lower the incidence of pulmonary complications as a result of more normal respiratory excursions. This problem is now being investigated further by one of us (J.A.G.)

A careful search of the literature fails to reveal any reference to the previous application of prolonged anesthesia in oil to abdominal incisions. In an effort to determine the feasibility of the use of this type of anesthesia in abdominal surgery we devised animal experiments to simulate, as closely as possible, operative conditions in the human subject. We used the incisions and suture materials commonly employed, together with the local anesthetic in oil which we have found to be superior to others commonly used.

CLINICAL APPLICATION AND CHOICE OF LOCAL ANESTHESIA IN OIL

In the Vanderbilt Clinic, Presbyterian Hospital, and in the senior author's private practice, we have operated upon 429 entirely ambulatory patients, who were suffering from local anal disease and infected pilonidal sinuses, under infiltration anesthesia in oil without any preliminary medication. We have injected this type of anesthetic material subcutaneously several times for widely distributed facial pruritus, intercostal neuralgia, and peripheral cervical neuritis without any untoward effects.

One of us (C.V.B.) is now carrying on experiments to determine the usefulness of this type of anesthetic in nerve block and spinal anesthetics. We have used all of the better known anesthetics in oil, and have had infection or necrosis of clinical significance in 2 of our anal cases in the presence of new preparations of oil anesthesia or an incidence of 0.004 per cent, and no infection or necrosis in our 427 other cases in which our regular anesthetics in oil were used. This incidence includes the use of all of the better known oil anesthetics and involves those patients cared for during the development of our present very satisfactory technique.

For more than 4 years we have used neothesol and with this preparation have had no infection or necrosis. We have experienced almost none of the redness and induration which not infrequently accompanies the administration of the other preparations. Neothesol has been so satisfactory in our hands that we have used it exclusively in our experiments.

Animals. Cats, weighing on an average of 3.95 kilograms were selected for the experimental work. A total of 20 animals was used.

General anesthesia. During the early experiments the cats were anesthetized by the intraperitoneal injection of nembutal, 30 milligrams per kilogram of body weight in normal saline. Two animals died of what seemed to be nembutal intoxication. Following this, we used ether inhalation anesthesia in all operations and biopsies.

Preparation of the skin. The operative area was shaved, washed with ether and alcohol, then painted with a 3½ per cent tincture of iodine, which was removed with 95 per cent alcohol.

From the Department of Surgery, Presbyterian Hospital, and the Laboratory of Surgical Pathology, College of Physicians and Surgeons, Columbia University.

TABLE I.—CLEAN AND DISCHARGING WOUNDS

Local infiltration	No. of wounds	Silk closure		Catgut closure	
		Clean	Discharging	Clean	Discharging
No oil —(control)	8	1	4		3
Plain oil	4	1	1		2
Anesthesia in oil	18	7	1	3	7
Totals	30	9	6	3	12

Incisions and controls. Transverse and muscle splitting, upper and lower rectus incisions 7 centimeters long were made through the entire abdominal wall including the peritoneum. The experiments were controlled by making some incisions without local infiltration, others after the infiltration of plain sterile almond oil, which is the base of the anesthetic, and still others after the local anesthetic, neothesol, was injected into all layers of the abdominal wall.

Thirty primary abdominal incisions and 56 biopsy excisions of parts of the abdominal wall were made on a total of 20 animals. Three of these primary incisions were upper transverse, 17 upper split rectus, and 10 were lower split rectus incisions.

Intra-oral infiltration of anesthesia in oil. In 4 instances 3 cubic centimeters of neothesol was injected into the submucosal spaces of the cheeks of the cats. The infiltration extended from the angle of the mouth to the base of the tongue. This represented an exceedingly large amount of anesthetic in oil for the small space into which it was injected. Frequent inspections of these areas and the microscopic studies on the tissue removed showed no inflammatory reaction. This suggests the possibility of the use of this type of anesthetic in tonsillectomies and particularly in dental and other specific nerve blocks.

Technique of injection of plain or anesthetic oil. Three or 4 cubic centimeters of the material desired was injected throughout the thickness of the abdominal wall, so that about 1½ cubic centimeters was deposited in the subcutaneous tissue, 1½ cubic centimeters into the muscle layer beneath the fascia, and 1 cubic centimeter into the properitoneal layer. This represents far more oil or anesthetic material per kilogram of body weight per cat than would be used in a human subject.

The incision was made immediately through this line of injection, and usually some of the oil was seen to escape from the incised tissue.

Suture material. Fine silk and catgut sutures were used in closing all types of incisions, that is, in the controls, without any local injection, as well as those with plain oil and with anesthetic oil. Both continuous and interrupted sutures were used in all combinations with little or no difference in the effect. Catgut and silk were not combined in the depth of any wound, although silk was used to close the skin in all instances.

In 15 incisions fine silk sutures were used throughout. In 15 other incisions plain No. 00 catgut was used in the peritoneum, chromic No. 00 in the fascia, and interrupted fine silk in the skin. Silk was used in 5 control incisions without any local injection of plain or anesthetic oil, in 2 instances where plain oil was injected, and 8 times in the presence of anesthetic oil.

Catgut was employed in 3 control incisions without plain or anesthetic oil, twice in the presence of plain oil, and 10 times following injection of anesthetic oil.

These 30 incisions, including 8 controls, provide a fair distribution of controls and possible combinations of plain and anesthetic oils and suture materials of silk and catgut (Table I).

Clinical interpretation of results. The interpretation is on the basis of clean wounds as opposed to those from which there was observed any discharge at any time. Cultures were not taken, and, therefore, we cannot use the term "infected."

Of the 15 wounds closed with silk, 5 were controls, without any oil or other local injections, 1 or 20 per cent of which remained clean and 4 or 80 per cent showed discharge. Two were injected with plain, sterile, almond oil, 1 or 50 per cent of which remained clean, and the other showed discharge. Eight were infiltrated with neothesol, 7 or 87½ per cent of which remained clean and 1 or 12½ per cent showed discharge.

Of the 15 wounds closed with catgut, the 3 or 100 per cent without any local injection and the 2 or 100 per cent with plain oil in the

Fig. 1. Abdominal wound; silk closure; no oil infiltration; 3 weeks after operation. Wound healing, *A*, is good; there is practically no reaction about the silk sutures, *B*. Breast tissue, *D*, is seen in the subcutaneous area. ×9.

incision showed discharge, and 3 or 30 per cent remained clean.

Thus, out of a total of 15 incisions closed with catgut, 12 or 80 per cent presented discharge, while of 15 incisions closed with silk, 6 or 40 per cent showed discharge.

In the vast majority of the silk wounds the discharge was slight and was confined usually to a small part of the incision. Skin necrosis, due to pressure from sutures, was by far the commonest factor in accounting for the discharge.

In the wounds closed with catgut the discharge was more profuse, and frequently a part of the wound broke down. The presence of catgut, even in the controls without local injection, always signalized the outpouring of discharge, in contrast to the far less frequent discharge in the presence of silk.

Fig. 2. Abdominal wound; silk closure; almond oil infiltration; 2 weeks after operation. Wound, *A*, which shows good healing, extends through the entire specimen. Silk sutures, *B*, and oil spaces, *C*, in the center of the field show relatively little surrounding reaction. ×9.

Résumé of results. In view of the very high incidence of discharge, 80 per cent, from all wounds sutured with catgut, we must consider this form of suture material undesirable in the cat. However, in wounds sutured with silk, the 40 per cent incidence of discharge was much lower, and most of those showing discharge were control cases. Inspection of Table I shows that in the wounds containing anesthesia in oil, sutured with silk, there was discharge in 1 or 12½ per cent, which is by far the best combination in our series. The wounds sutured with catgut in the presence of anesthetic oil showed a discharge in 7 or 70 per cent of the cases, which is better than in the control series; all 5 or 100 per cent showed discharge, including 3 without any local and 2 with plain oil infiltration.

Biopsy of wounds. Sections were taken through all layers of the abdominal wounds which had healed *per primam*, at intervals of 1 and 2 weeks, and usually at 4 weeks or later following the initial incision, in order to obtain material for study at varying periods in the healing process. In those cases showing

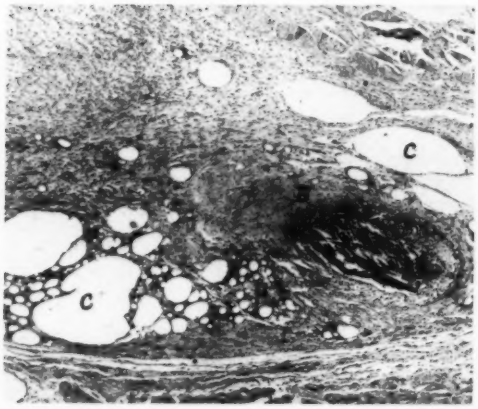

Fig. 3. Abdominal wound; silk closure; almond oil infiltration; 2 weeks after operation. Practically no reaction is present about the oil spaces, *C;* there is slight semilunar area of reaction about the silk suture, *B*. ×25.

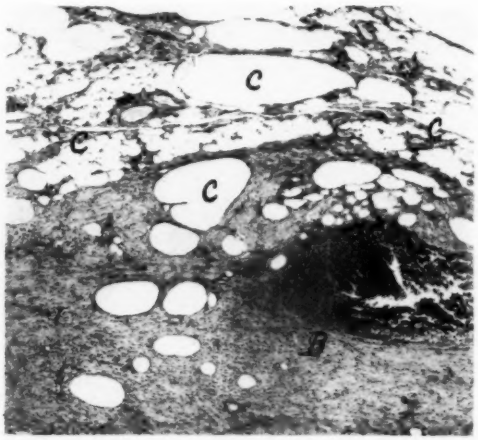

Fig. 5. Abdominal wound; silk closure; anesthesia in oil infiltration; 2 weeks after operation. Compare absence of reaction around the oil spaces, *C*, with Figure 3 (plain oil); slight reaction is seen around the silk suture, *B*, as in Figure 3. ×33.

marked reaction or discharge, operative procedures were deferred until these manifestations had cleared up and the wound was firmly healed.

In order to get representative sections, the first 2 biopsies were taken near the extremities of the wound transversely to the initial incision but well within the originally incised area, and the third was taken through the center. It is conceivable that the reaction about a previous biopsy wound could affect the histological picture of the original incision. However, on the whole, it was felt that representative sections were obtained in this manner.

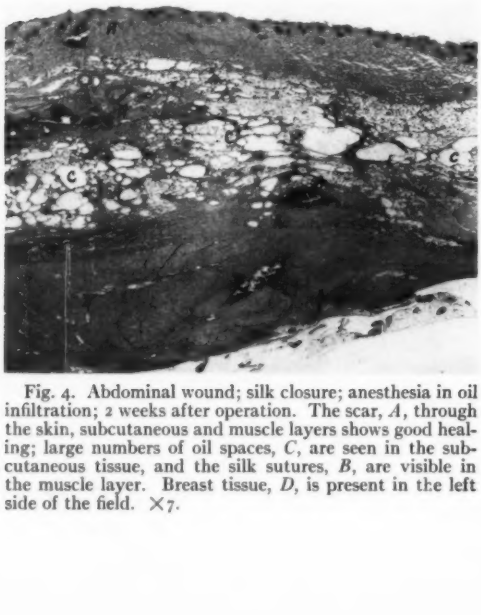

Fig. 4. Abdominal wound; silk closure; anesthesia in oil infiltration; 2 weeks after operation. The scar, *A*, through the skin, subcutaneous and muscle layers shows good healing; large numbers of oil spaces, *C*, are seen in the subcutaneous tissue, and the silk sutures, *B*, are visible in the muscle layer. Breast tissue, *D*, is present in the left side of the field. ×7.

MICROSCOPIC STUDY OF THE SECTIONS THROUGH THE ABDOMINAL WOUNDS

1. Silk closure—no oil (*Fig. 1*). A small dip or thickening of the epithelium is usually present at the site of the scar. Beneath this the scar tissue can be seen extending through all layers, including the peritoneum. Early the fibroblasts appear large and frequently are multinucleated. A varying degree of leucocytic infiltration, composed of polymorphonuclears, lymphocytes, and sometimes eosinophiles and plasma cells, is present. Multinucleated, foreign body, giant cells are sometimes seen in small numbers. The granulation tissue is permeated by many capillaries, and in some areas organization of previous areas of hemorrhage is found. Later, the cellular reaction has largely disappeared and the cicatrix is composed of rather densely organized fibrous tissue.

The silk sutures and ligatures are found in the deeper portions of the wound, and are

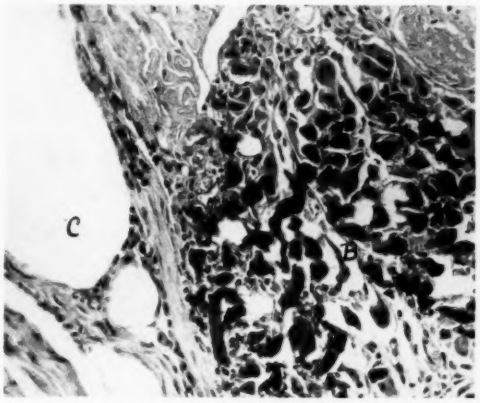

Fig. 6. Abdominal wound; silk closure; anesthesia in oil infiltration; 2 weeks after operation. Silk fibers, *B*, are separated by granulation tissue and inflammatory cells; many multinucleated giant cells are present; large oil space, *C*, adjacent to the silk sutures shows no peripheral reaction. ×115.

Fig. 7. Abdominal wound; silk closure; anesthesia in oil infiltration; 10 weeks after operation. Scar tissue, *A*, is firm; only a few small oil spaces, *C*, remain in the subperitoneal tissue. ×25.

arranged usually on either side of the cicatrix. The entire suture as well as the individual fibers are surrounded by a minimal exudate and inflammatory reaction. This reaction varies considerably in different locations and at different stages in the healing process. It is usually slight, however, and is soon replaced by actual infiltration and ingrowth of fibroblasts, so that ultimately there is a thickening of tissue about the periphery of the suture material as well as a network of fibrous tissue between the individual strands. In many instances the zone adjacent to the scar shows relatively little fibroplasia, while the opposite side shows a rather wide semilunar area of fibrosis, which is apparently the result of proliferation of tissue, which resulted in the obliteration of the dead space created by pressure of the suture on the tissue as illustrated in Figure 3.

2. Silk closure—almond oil infiltration (*Fig. 2*). These wounds show essentially the same picture as that just described with the addition of multiple round or ovoid spaces scattered throughout the tissue and varying considerably in size. It is obvious that these vacuoles represent the loculi in which oil was retained before section of the tissue. These areas are devoid of cellular exudate or débris, and are surrounded by a syncytial lining layer usually 1 or 2 cells in thickness. Rarely are polymorphonuclear cells found, and no evidence of tissue necrosis has been noted. In many areas numerous spaces are grouped together, and the scant surrounding tissue forms a syncytium.

Healing progresses in the usual manner, and no apparent interference with wound healing, due to the presence of the oil, is noted (Fig. 3). The reaction about the silk sutures is quantitatively and qualitatively about the same as in the wounds without oil.

3. Silk closure—anesthesia in oil infiltration (*Fig. 4*). Wound healing appears to progress in a normal manner. There is no discernible difference in the reaction about the oil in these sections as compared to the almond oil controls. The reaction is very slight and seems to be controlled somewhat by the amount of oil and the pressure with which it has been injected rather than by factors intrinsic to the oil. When excessive amounts are introduced under great pressure, the reaction is correspondingly more marked.

The reaction about the silk sutures is not altered by the presence of oil (Figs. 5 and 6).

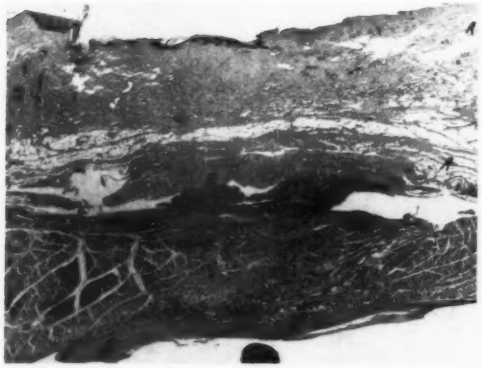

Fig. 8. Abdominal wound; catgut closure; no oil infiltration; 3 weeks after operation. The round marker indicates the site of a small fragment of catgut, *F*, remaining in the subperitoneal tissue; the scar, *A*, is seen through the subcutaneous and muscle layer; the granulation tissue and exudate, *E*, are seen adjacent to the muscle layer; nipple and breast tissue, *D*, are at the left. ×7.

This process seems to depend entirely upon factors intrinsic to the silk and the manner in which the silk has been placed in the tissue.

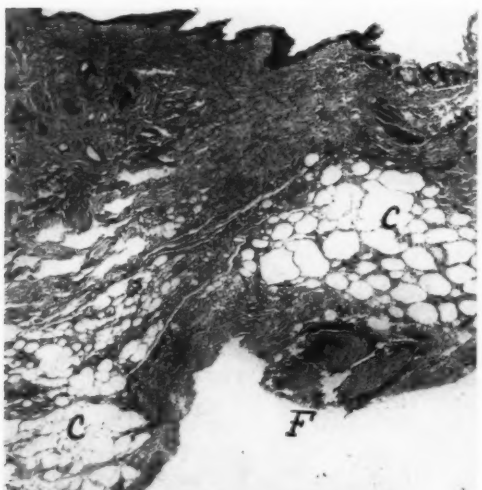

Fig. 10. Abdominal wound; catgut closure; anesthesia in oil infiltration; 2 weeks after operation. There is some fragmentation of the catgut suture, *F;* almost no reaction is seen about the oil, *C*, which is in excess in the subcutaneous tissue. ×33.

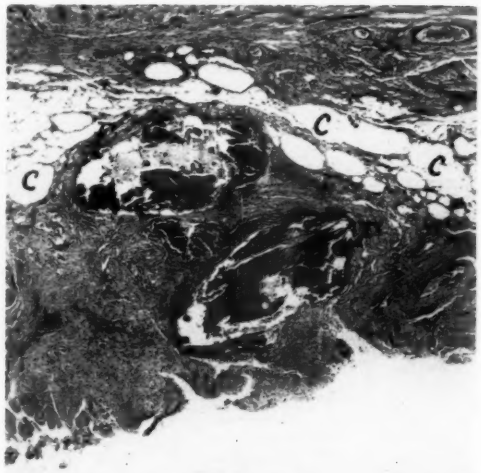

Fig. 9. Abdominal wound; catgut closure; almond oil infiltration; 7 weeks after operation. There is marked catgut, *F*, absorption, and some residual oil spaces, *C*. ×33.

The oil appears to accumulate largely in the subcutaneous and properitoneal areas, while that injected into the muscle seems to be absorbed earlier. Multiple small spaces are seen in the muscle in the early sections, while practically none can be found in the late sections. At 10 weeks (Fig. 7) the only evidence of oil is found in the properitoneal tissues, and here no particular reaction or tendency to adhesion formation can be made out.

4. Catgut closure—no oil (Fig. 8). The sections show essentially the same picture of wound healing as was described for the silk wound except for the fact that there are considerably more edema and inflammatory reaction through the cicatrix and about the suture material. Many polymorphonuclear cells are present early, especially throughout the granulation tissue and about the catgut sutures. Fibroblastic proliferation seems to progress actively, and the cicatrix appears to be quite firm at the end of 2 weeks. During this period the catgut sutures, which appear initially as single strands, usually become swollen and fragmented. Inflammatory cells infiltrate the spaces between the strands, and an irregular absorption occurs, which gives the appearance of a scalloped margin in cross

section. In many sections digestion of the catgut is far advanced within 3 or 4 weeks, while in others relatively little change is observed. In all, however, a relatively more marked inflammatory reaction about the periphery is noted than in the wounds closed with silk sutures. In the sections taken late, the polymorphonuclear cells have disintegrated, and a dense network of fibrous tissue, containing giant and plasma cells, is present.

5. Catgut closure—almond oil infiltration (*Fig. 9*). There is evidence of fairly good wound healing, in spite of quite marked inflammatory reaction about the catgut, which is digested at approximately the same rate as in the control sections without oil. There appears to be no relationship between the reaction about the catgut and the presence of oil. In many areas oil spaces are seen adjacent to a catgut suture, and frequently there is an intense reaction about the suture material, while the usual single layer of lymphocytes and fibroblasts surrounds the oil globules.

6. Catgut closure—anesthesia in oil infiltration (*Fig. 10*). Wound healing progresses as favorably as in the catgut control cases. The inflammatory reaction in the wound and also around the catgut is of moderate degree. The variation in the rate of catgut absorption is again noted (Fig. 11). Here, also, the oil spaces are distributed throughout the tissue, but there is a tendency to concentration in the subcutaneous and properitoneal tissues. Early the spaces are large and the reaction is slight to moderate. The spaces become progressively smaller, and the mild peripheral cellular reaction decreases. In a section taken at 7 weeks only a few small oil spaces and several fragments of incompletely absorbed catgut are seen. The cicatrix is firm and the peritoneum is intact.

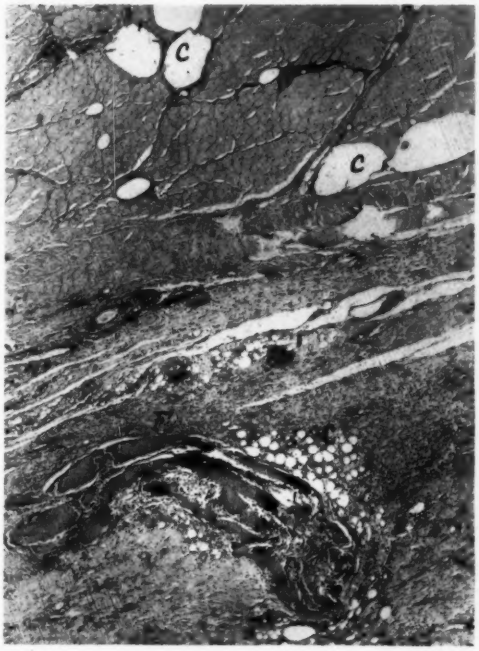

Fig. 11. Abdominal wound; catgut closure; anesthesia in oil infiltration; 2 weeks after operation. Catgut, *F*, which is sectioned longitudinally, shows fragmentation; oil spaces, *C*, in the muscle and adjacent to the catgut show no inflammatory reaction. ×25.

SUMMARY AND CONCLUSIONS

1. Typical abdominal incisions were made into the peritoneal cavity of cats, some without any local anesthetic infiltration, others following the injection of plain almond oil locally, and others after the local infiltration of anesthesia in oil.

2. Catgut and silk were used separately to close the deeper layers of all types of wounds.

3. Catgut in all these wounds caused marked local inflammatory reaction and signalized the outpouring of serum, irrespective of whether or not there was any local oil infiltration into the tissues.

4. There was slight reaction in the wounds closed with silk, and this would seem to be a desirable form of suture material in the cat.

5. Of 15 incisions closed with catgut, 12 or 80 per cent showed discharge.

6. Of the 15 incisions closed with silk, 6 or 40 per cent presented discharge.

7. In the 8 control cases, without local infiltration, 4 or 80 per cent with silk closure and 3 or 100 per cent with catgut closure showed discharge.

8. In the 4 instances in which plain almond oil was infiltrated, 1 or 50 per cent closed with silk and 2 or 100 per cent with catgut closure showed discharge.

9. In the 18 cases into which anesthesia in oil (neothesol) was infiltrated, 1 or 12.5 per cent closed with silk and 7 or 70 per cent closed with catgut presented discharge.

10. There is no evidence to suggest that the presence of almond oil, plain or anesthetic, in any of the wounds increased the incidence of discharge with either type of suture material.

11. These findings indicate that anesthesia in oil or plain oil does not cause any delay in wound healing or any tendency for the wounds to break down or discharge.

12. The fact that the oil in these wounds does not show any appreciable surrounding inflammatory reaction suggests the possibility of using this type of infiltration anesthesia in human incisions.

13. The absence of gross or microscopic reaction in the cheek of the cat after a local anesthetic in oil infiltration was used suggests its use in tonsillectomies or nerve block and, possibly, in spinal anesthetics. The senior author is now carrying on experiments along this line.

THYROID DISEASE IN THE SOUTHERN NEGRO

A Comparative Analysis of 470 White and 482 Negro Cases from Charity Hospital of Louisiana at New Orleans

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WHEN S. A. Cartwright, in 1851, made his report to the Medical Association of Louisiana on a study of the diseases and physical peculiarities of the negro, he said that negroes were so different from white persons that it would be safer for overseers, who knew no medicine but who did understand their racial peculiarities, to treat them empirically when they were ill than for the queen's own physician to attend them. To physicians and surgeons who practice in the South that statement is not altogether absurd. It contains an important truth in its implication that the manifestations of certain diseases differ in the negro and white races.

In 1887, when a group of southern physicians discussed the surgical problems of the negro before the American Surgical Association (31), they pointed out that certain surgical affections pursue different courses in the negro and in the white man under identical hygienic surroundings. The mulatto was a less good surgical risk than the pure black negro, they pointed out, but negroes as a race bore surgical injuries and operative procedures better than white men, and recovered from them more speedily, because their nervous systems were less sensitive.

In 1896, when Matas published his classical monograph entitled, "The Surgical Peculiarities of the American Negro," for almost the first time the variations in the incidence and mortality of certain diseases in the negro and white races were analyzed scientifically. Matas' source was the enormous clinical material of Charity Hospital of Louisiana at New Orleans, and racial differences in disease furnish as many problems for the surgeon of 1939 in that institution as they did for the surgeon of 1896.

One or two of the more recent studies from Charity Hospital might be mentioned to illustrate this point. Kampmeier found arteriosclerosis in 41.8 per cent of 239 consecutive negro males under 40 years of age who were being treated for other conditions and in whom hypertension, cardiac disease, and nephritis could not be demonstrated. Cutting and his associates found by means of the Kahn test an incidence of syphilis amounting to 35.5 per cent in 509 negro males who had applied for surgical treatment; the incidence rose to 49.5 per cent when less strict laboratory criteria were applied. Miller (23, 24) and others have pointed out that uterine fibroids are 9 times more frequent in negro than in white women and very much larger, and that pelvic inflammatory disease is more frequent and more extensive. In a study of 2,715 cases of acute appendicitis (3) we found that negroes furnished less than 25 per cent of the incidence but more than 40 per cent of the mortality. We (6) also found a similar though less marked disproportion between the negro incidence and mortality in 404 surgical cases of biliary tract disease.

Such figures as these seem to justify the speculation that diseases to which the negro is immune in his native environment manifest themselves with special virulence when he is transplanted elsewhere. This or some other theory is needed to explain certain phases of thyroid disease in the negro in Charity Hospital of Louisiana.

COMPARATIVE RACIAL INCIDENCE

During the 12½ year period ending July 1, 1938, 952 patients with thyroid disease were treated in this institution by 976 operations; i.e.,

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TABLE I.—DISTRIBUTION OF THYROID DISEASE IN THE NEW ORLEANS CHARITY HOSPITAL JANUARY 1, 1927–JULY 1, 1938

Distribution	Cases No.	Deaths No.	Mortality per cent
Total cases	952	50	5.3
White	470	17	3.6
Negro	482	33	6.8
Male	105	15	14.3
Female	847	35	4.1
Non-toxic	532	12	2.3
Toxic	420	38	8.8
Diffuse	476	33	6.9
Nodular	476	17	3.6

an incidence of 1:596 in the 567,214 admissions and 1:173 in the 168,385 operations which were performed, exclusive of nose and throat operations, during the same period of time.

The white incidence (470 cases) is 1:691 in 324,969 admissions and the negro (482 cases) 1:503 in 242,245 admissions. The proportion of white to negro admissions is thus 57.2 to 42.8, but the proportion of surgical thyroid disease is 49.3 to 50.7. These figures do not represent the absolute proportionate incidence of thyroid disease in this area. The New Orleans Charity Hospital supplies the medical needs of most negroes in Louisiana, as well as in New Orleans, but indigent white patients can be cared for in several other institutions as well. The figures make no provision, furthermore, for patients who can pay for their medical services, although the number of these in the negro race is relatively insignificant. The negro population is 29 per cent in New Orleans, according to Association of Commerce figures, and 36.9 per cent in Louisiana.

A consideration of the figures from the standpoint of toxicity (Table I) effectually disposes of the idea, which was once very widely held, that toxic thyroid disease is rare in the negro. As a matter of fact, it follows rather roughly the ratio of negro and white hospital admissions. The diffuse variety of toxic disease is more frequent than the nodular in the negro, although in non-toxic disease the reverse is true.

COMPARATIVE RACIAL MORTALITY

Far more striking than the variations in the incidence of thyroid disease in the two races are the disparities in mortality, and particularly in the mortalities according to sex distribution (Tables I and II). The mortality for the whole series of 952 cases is 5.3 per cent, which is high even for a non-endemic area. The negroes, who furnish just over half of the incidence, furnish almost two-thirds of the mortality. The total male mortality of 14.3 per cent, or 15 of 105 cases, is more than four times the female mortality of 3.5 per cent, or 33 of 847 cases. In females, the negro mortality is higher than the white mortality in both varieties of non-toxic disease, but the differences are not disproportionate. In both varieties of toxic disease, however, it is more than twice as high. In males, the negro death rate far exceeds the white in all varieties of thyroid disease, and in the toxic variety it rises to shocking figures. These disparities are beyond explanation, for no argument would seem to apply to the negro male which does not apply to the negro female as well.

In both negro and white subjects the mortality for diffuse toxic disease is higher than for nodular toxic disease. This circumstance, which is contrary to the usual experience, is also difficult to explain, since in nodular toxic disease the hazards of cardiac disease and other visceral damage are added to the inherent hazards of toxic thyroid disease.

It is interesting and perhaps significant that more than two-thirds of all the patients were treated during the last 5½ years of this study, and that almost three-quarters of the negroes were treated within this period. In recent years the white mortality has shown some improvement, but the negro mortality has continued very high, which perhaps is further evidence of the inherently more serious character of this disease in the race.

As we have pointed out elsewhere (1) our figures are entirely representative of thyroid disease in this community. Less than half of the deaths from thyroid disease in New Orleans occurs in the public institution where one might reasonably expect to find most of them, though practically all of the negro deaths, for obvious reasons, occur in it. It

might be pointed out also that in the 5 year period ending in 1937 there was only 1 year in which the local death rate for toxic thyroid disease was even fractionally lower than the national rate, and in 1 year it was twice as high. During the same period the local death rate for non-toxic disease was from 2 to 8 times higher than the national rate.

COMPARISONS WITH OTHER SERIES

Very few series of cases are available for comparison with the New Orleans figures. The reports of Jones, Clifton, and Davison and Poer, from Atlanta, Drennan, from Alabama, and Street, from Mississippi, do not emphasize the racial factor. Hermann's report of 40 cases of hyperthyroidism in the negro is from a northern hospital (Lakeside) and it is doubtful whether northern negroes are comparable with southern negroes, who in many respects present a peculiar medical and economic problem. The negro in the South is chiefly dependent upon the white man for his livelihood and for his medical care, most of which is secured in public institutions. He has lower standards of living than the white man, has elementary ideas of hygiene and sex relationships, and is slow in seeking medical aid, perhaps because he is apparently less sensitive to pain and to nervous stimuli than the white man. The northern negro, on the other hand, has adapted himself to the ways of civilization and more nearly approaches the white man in his reactions.

Porter and Walker, from Richmond, Virginia, report 36 cases of hyperthyroidism in negroes, who were treated, with a mortality rate of 11.4 per cent; 2 patients died in crisis immediately after admission, and there were 4 deaths in the 34 surgical cases. During the same period 71 white patients were treated by the same staff with no deaths. These authors attribute the high negro mortality to delayed treatment rather than to inherently more serious disease. Lehman and Shearburn, from the University of Virginia Hospital, report a 9.43 per cent mortality in 53 negro patients with hyperthyroidism (6 males and 47 females) against a mortality of 0.84 per cent in 237 white patients. The mortality in both these series approaches the mortality at New Orleans Charity Hospital, though at the University of Virginia, contrary to our experience, all the negro deaths occurred in females.

TABLE II.—RACIAL AND SEX DISTRIBUTION OF THYROID DISEASE IN THE NEW ORLEANS CHARITY HOSPITAL—JANUARY 1, 1927–JULY 1, 1938

Distribution	Cases No.	Deaths No.	Mortality per cent
Diffuse non-toxic	248	6	2.8
White male	19		
Negro male	21	4	19.0
White female	94	1	1.1
Negro female	112	2	1.8
Nodular non-toxic	284	5	1.6
White male	10		
Negro male	12	2	16.6
White female	110	1	0.9
Negro female	152	2	1.3
Diffuse toxic	228	26	11.4
White male	23	4	17.4
Negro male	12	4	33.3
White female	111	7	6.3
Negro female	82	11	13.4
Nodular toxic	192	12	6.2
White male	4		
Negro male	4	1	25.0
White female	99	4	4.0
Negro female	85	7	8.2

No general survey of the incidence of thyroid disease has been made in New Orleans. In Manhattan there was a slightly lower incidence of thyroid enlargement in negro than in white school children (9). In Cincinnati the incidence was slightly higher. In Rutherford County, Tennessee, as well as in Murfreesboro, Tennessee, in a controlled study the negro incidence of thyroid enlargement was considerably higher than the white (25).

THE CYCLE OF THYROID DISEASE IN THE NEGRO

The incidence of thyroid enlargements in young negroes in the studies just quoted seem indirectly to support the contention we have made in previous communications (19–21), namely, that toxic thyroid disease in southern negroes, as is usual in endemic areas, seems to arise on the basis of a previous non-toxic dif-

fuse goiter, whereas in white subjects it arises as virgin pathology. The simple type of goiter, which amounts to little more than an enlargement of the neck, is fairly frequent in young negro women. We have kept a number of such patients under observation for several years, and in most instances the gland has either not increased in size or has decreased. We believe, therefore, that we are justified in saying that symptomless thyroid enlargements in young negro women in this community should be operated upon only after a period of observation. This type of goiter gives rise to no symptoms *per se*, and in most cases no further pathological change occurs.

Although 22 negro patients in the toxic and 6 in the non-toxic group dated their goiters or their thyroid symptoms to pregnancy, puberty, the menopause, an operation, an illness, or a shock, we do not accept the histories at their face value. In previous communications we have called attention to the tendency of negroes to exaggerate their "miseries" and to furnish any symptoms expected of them, and that tendency undoubtedly explains why certain patients attributed their illnesses to special circumstances or facts. Negroes are phlegmatic; they take life as it comes; their emotions are superficial and noisy rather than deep-seated and essential; and the negro woman who, according to her own story, developed her goiter after she had "hollered two days twenty years ago," when her mother died, is quite typical of the race.

In some negroes, however, whatever the reason or whatever the special strain upon the organism which fans the gland into activity, the inactive gland is stimulated and the toxic diffuse stage is reached. The white patient is likely to present himself for treatment at this stage; the negro is not, perhaps because his sensibilities are less keen, his toxic manifestations less marked, or perhaps because thyroid disease is not associated with pain, which is the negro's chief reason for seeking medical attention. Any one of these explanations, or all of them, may account for the fact that toxic diffuse goiter formed 19.5 per cent, or 94 of 482 cases, of the negro incidence against 28.5 per cent, or 134 of 470 cases, of the white incidence.

In the natural cycle the diffuse toxic stage wears itself out and the gland passes over into the non-toxic stage. Whether or not toxic manifestations reappear depends upon whether or not the stimuli, known or unknown, which were responsible for the original activity again become effective. This cycle of events, in our opinion, accounts for the fact that non-toxic nodular goiter formed 34.0 per cent of all the negro cases, or 164 of 482 cases, against 25.5 per cent of the white, or 120 of 470 cases.

It is quite possible that in some instances the gland may return to the original colloid or resting state, by the working of the law that all thyroid disease eventually burns itself out if it does not first burn out the patient. This surmise is supported by the fact that there were 45 cases of diffuse non-toxic goiter in negroes over 40 years of age against 22 cases, less than half that number, in the whites.

POSSIBLE EXPLANATIONS OF THE NEGRO DEATH RATE

Such speculative reasoning explains the difference in the incidence of the various types of thyroid disease in the negro and white races, but does not explain the differences in the mortality. In this community no single surgeon sees enough cases of thyroid disease to permit him to become really familiar with the condition, and to that lack of experience part of the general mortality can be attributed. The 976 operations on the 952 patients were performed by 68 surgeons, 1 of whom performed 106 operations, incidentally with only 1 death, in a negro, while another performed 63 operations with 4 deaths. At the other end of the list, 6 surgeons operated on 2 patients each and 9 on 1 patient each. But such an explanation does not explain the difference in the white and negro mortalities. Fifty-four surgeons operated upon the white and 50 on the negro patients; 37 operated upon patients of both races. When the same men operated on both colored and white patients the surgeon's mortality was almost invariably higher in the negro wards.

Part of the negro mortality is undoubtedly to be attributed to the inadequate and over-

crowded negro hospital facilities. It is not unusual, and often a necessity, for very ill patients to be kept 2 in a bed. Isolation and quiet are practically impossible; the negro fundamentally is unwilling to be alone. Within the last 2 years, during which the old hospital was torn down and the new one erected, the negro facilities have been particularly inadequate and the noise and confusion have had a deleterious effect particularly upon toxic thyroid patients. In at least 4 negro cases, of which I have personal knowledge, the unpropitious hospital environment played a definite part in the fatal outcome. The new hospital will shortly be occupied, and it will be interesting to see whether improved facilities will improve the negro mortality.

Part of the negro mortality can be explained by the racial tendency to delay medical consultation. As a result, the goiters are large and adherent, are often substernal, and the resultant tracheal distortion causes serious respiratory difficulties at operation. There were 69 substernal glands among the negro subjects, as compared with only 32 in the white, and most of the deaths from respiratory collapse occurred in negroes with large goiters. Adequate exposure of the glands is often difficult in negroes. Because of their habit of carrying large bundles on their heads and the fact that so many of them perform hard physical labor, their neck muscles are highly developed. This is a minor technical difficulty, however, which usually can be eliminated if the strap muscles are cut.

We personally have no doubt that although negroes develop toxicity less often than white subjects in this community, they develop it to a more intense degree. When iodine is administered properly, as it very often is not, there seems no particular difference in the negro and white response in most cases. Negroes are not as likely to have taken iodine before admission as white patients, because they are less likely to have had previous medical attention. In this series 43 white patients with toxic disease and 19 with non-toxic disease had taken iodine, against 25 toxic and 12 non-toxic negro patients. One negro, however, had ordered iodine from a mail order catalogue and had taken it for 10 years. Fifty-one negroes, according to the histories, had exophthalmos, against 25 white patients; but again we do not accept the negro figures unreservedly, for many of them have "pop" eyes from birth. The negro response to toxicity, as measured by temperature, pulse, respiration, and basal metabolic rate does not differ materially from the white response.

There is no doubt, however, regardless of these similarities, that the negro patient is frequently more toxic than the white patient, though his toxicity is by no means as evident. As a result, the seriousness of his disease is underestimated, and either preparation is inadequate or too much surgery is done. Several negro cases in this series, too, excellently illustrate the point made by Lehman and Shearburn, that it is unwise to defer operation too long, for the optimal time for it is past often before one realizes it. That 9 of the 31 negroes in whom stage surgery was attempted or completed lost their lives, against 3 of 31 white patients, seems to suggest again that toxic thyroid disease is more serious in the negro than in the white subject.

CAUSES OF DEATH

In toxic diffuse thyroid disease 6 of the white and 9 of the negro deaths were due to crisis, 3 of the white and 1 of the negro to cardiac disease, and 2 of the white and 2 of the negro deaths to pneumonia. One negro died of respiratory collapse, 1 under the anesthetic, and 1 after a Naffziger operation for progressive exophthalmos. The last patient, a negro girl 6 years old, although exceedingly toxic, had weathered 2 lobectomies successfully.

In nodular toxic disease all 4 white deaths were due to crisis. Two negro deaths were due to crisis, 2 to respiratory failure, and 3 to cardiac disease. From July 1, 1938, when this study ended, until March 15, 1939, 2 other surgical deaths from toxic thyroid disease occurred in Charity Hospital, both in negroes; 1 patient died on the table and another died in crisis shortly after lobectomy.

In diffuse non-toxic thyroid disease 1 white patient and 1 negro died of hemorrhage. Two negro deaths were due to pneumonia, and 1 each to shock, respiratory collapse, and

TABLE III.—LIVER FUNCTION (IN TERMS OF NORMAL) IN 130 CASES OF THYROID DISEASE STUDIED BY THE QUICK TEST

Type	Pre-operative (days)		Postoperative (days)			
	1	2*	1	2	3	7
White diffuse	94.0		76.4	69.7	95.3	90.8
Negro diffuse	79.2		63.2	82.0	95.1	82.8
White diffuse toxic	61.3	91.8	61.7	48.1	70.7	83.7
Negro diffuse toxic	69.3	77.3	76.4	74.7	86.2	88.8
White nodular	85.0		82.9	78.2	82.1	82.9
Negro nodular	83.5	105.6	82.9	78.2	82.1	82.9
White nodular toxic	83.0	99.4	75.6	.....	82.5	87.7
Negro nodular toxic	57.6	79.3	75.9	68.5	54.9	77.9
Negro nodular**	86.6	169.3	120.8	130.0	103.5	77.0
Negro nodular toxic**	56.1	85.0	85.0	82.0	114.8	60.9

*After preparation.
**Prepared with oral decholin, treated postoperatively with oral decholin and intravenous glucose.
Note the abrupt decrease in function on the second and third days, when the supportive therapy is withdrawn.

a persistent thymus gland. In nodular non-toxic disease 1 white patient and 1 negro died of hemorrhage. The 3 other negro deaths were due respectively to cardiac disease, respiratory collapse, and pneumonia. Between July 1, 1938, and March 15, 1939, 2 other surgical deaths from non-toxic thyroid disease occurred in Charity Hospital, both in negroes and both due to respiratory collapse.

During the period under discussion 21 negroes died from toxic thyroid disease without surgery, 18 from crisis, against 18 white patients, 15 of whom died from crisis. From July 1, 1938, to March 15, 1939, 9 other non-surgical deaths have occurred, 8 of which were in negroes and 5 of which were caused by crisis. The fact that 39 of the 49 non-surgical deaths occurred within the last 5 years is not the least disturbing feature of the situation. Some of the negroes entered the hospital in crisis, and 1 or 2 were practically moribund; but in other cases death occurred because the intensity of the toxicity was not realized, because medical treatment was continued too long, or because the optimal time for surgery was permitted to pass. All these figures furnish convincing proof of the serious character of both non-toxic and toxic thyroid disease in the negro.

THE LIVER FACTOR IN THYROID DISEASE

Within the last 2 years of this study the Quick (28, 29) hippuric acid test of liver function was performed on 130 patients, 85 of whom were negroes. Increasing experience has confirmed our earlier observation that in all varieties of thyroid disease the negro liver function is lower than the white (Table III). We (2, 4) have suggested elsewhere that the decreased function in non-toxic disease, which is evident in both negro and white subjects, although more marked in the negro, may be evidence of a latent toxicity, thus bearing out Hertzler's contention that no goiter is truly innocent.

The decreased hepatic function in the negro is easily explained by his tendency to ignore his symptoms and to permit his disease to progress. It is further explained, if our theory be correct, by the inherently more serious character of thyroid disease in the southern negro. Whatever the reason, the decrease in liver function probably explains part of the very high negro mortality. On the other hand, proper preparation will in most cases overcome the visceral damage. Most negro patients respond well to such simple measures as glucose and decholin by mouth (Table III) and it is my personal practice to employ these measures routinely, even in non-toxic cases, to overcome the fall in liver function which follows all operations (5). Such a fall, if the initial liver function is low, may readily progress beyond the lower limit of safety.

ETIOLOGY

We have, unfortunately, no data to explain the etiology of goiter in the negro. Webster and others have called attention to the goitrogenic properties of cabbage, which, with salt meat, is a favorite diet of negroes in this community. The dietary factor may play some part in the prevalence of simple goiter, but it does not, of course, explain toxicity. The soil of Louisiana has been proved to be rich in iodine, and the urinary iodine studies from Tulane University which Curtis quotes in comparison with his own, substantiate the amounts available. In central Ohio the average daily normal urinary excretion of iodine was 51 milligrams, as compared with 117

milligrams in New Orleans. Further studies along these and other lines seem indicated to explain the manifestations of goiter in the southern negro.

SUMMARY

1. An analysis of 952 cases of thyroid disease from Charity Hospital in New Orleans reveals a negro mortality almost twice as high as the white mortality. The disparity was particularly marked in both varieties of toxic disease and in negro males.

2. No explanation of the high negro mortality is entirely satisfactory and the speculation is advanced that the disease is actually more serious in the negro than it is in the white patient. The white mortality has shown considerable improvement in recent years, but the negro mortality remains at a high level.

3. In the negro, toxic thyroid disease seems to arise on the basis of a previous simple goiter, although in the white patient in this community it seems to arise as virgin pathology.

4. The decrease in liver function in negroes in all varieties of thyroid disease seems to support the idea that the disease is inherently more serious in this race.

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THE EFFECTS OF EUPAVERINE ON THE PULMONARY CIRCULATION

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DURING the past few years occasional articles have appeared in the literature describing the use of eupaverine in the treatment of peripheral and pulmonary emboli. In 1930, Wolfes and Kreitmair published an account of their studies on this drug, a synthetic preparation closely related chemically and pharmacologically to papaverine. Other reports on the clinical and experimental use of this drug have appeared since. A brief review of the literature and personal experimental observations are presented in this paper.

Eupaverine is 1—(3, 4 methylene-dioxybenzyl) (3 methyl-6, 7 methylene dioxyisoquinoline). It is a white, crystalline compound which melts at 140 degrees C. without decomposition. It is a weak base whose salts are decomposed by alkaline bicarbonates. The bisulphate dissolves readily in hot water.

The pharmacological effects of eupaverine are similar to those of papaverine. Samaan and Wolfes and Kreitmair found it to be half as toxic as papaverine. Samaan found eupaverine to be twice as active as papaverine, while Wolfes and Kreitmair found it 25 per cent more potent than papaverine.

Pal first demonstrated that papaverine had a paralyzing effect on smooth muscle fibers. He showed this effect when the drug was used alone and also when it was used after muscular spasm had been induced by epinephrine. Samaan found that 2 to 4 milligrams per kilogram caused a slight fall in blood pressure in experimental animals. The fall was proportionately greater with larger doses of the drug. The heart rate was increased with the larger doses. This increase in cardiac rate was abolished by a prior injection of atropine. Lethal doses caused cessation of respiration before the failure of heart action. In isolated hearts the drug slowed the heart rate and decreased the cardiac output. These effects were not influenced by atropine, showing that eupaverine acts directly on the muscle and not through the vagus or sympathetic nerves. Samaan also found that eupaverine acted directly on intestinal muscle, relieving spasm whether mediated through nerve, muscle, or both, in contrast to atropine which had no effect on direct muscle spasm.

Observations. It has been demonstrated repeatedly that after the lodging of an embolus in an artery the vessel distal to the embolized area goes into spasm. Hoping to overcome the effects of this spasm clinicians have used both papaverine and eupaverine in the treatment of arterial emboli. Kohlmayer reported several cases with peripheral arterial emboli in which striking improvement followed the use of eupaverine. Allen and MacLean observed a case of femoral embolus in which the circulation suddenly returned following the administration of papaverine.

Denk believed that the factor of spasm played an important part in the symptomatology of pulmonary embolism. In 1936, he reported 9 cases of pulmonary embolism treated with eupaverine. Seven of these recovered. He also reported 25 cases of peripheral arterial embolism treated with eupaverine, of which 17 recovered, 3 were improved, and 5 were not improved. In 1937, Domanig discussed the rationale behind the use of eupaverine in pulmonary embolism. He believed that the effects of pulmonary emboli could not be explained solely on the basis of mechanical occlusion of the pulmonary vessels but that vasospastic impulses, mediated through pulmonary vasoconstrictors, were set up by the presence of an embolus and that the resulting pulmonary arterial spasm was largely responsible for the symptoms produced. On this basis he advo-

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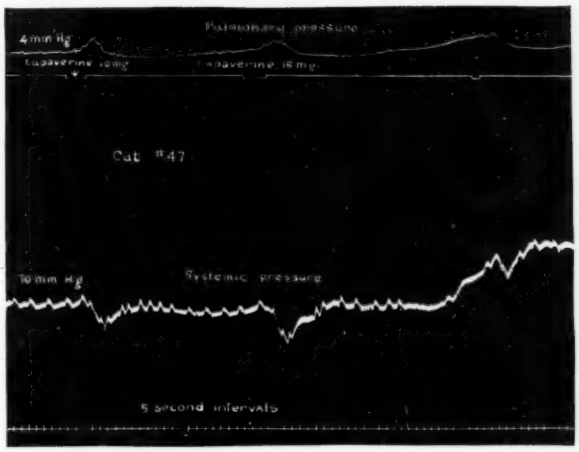

Fig. 1. Effects of eupaverine on pulmonary and systemic blood pressures.

cated the use of the drug in pulmonary embolism.

It is generally agreed that eupaverine has a spasmolytic effect. This is evidenced in the circulatory system by a fall in blood pressure. It is difficult to understand how a generalized fall in blood pressure can benefit the part distal to an embolus, in which the arterial pressure has already been reduced to a dangerously low level by the occluding embolus. German observers have spoken rather freely of spasm in the pulmonary arterial circuit. However, a thorough review of the literature on the pulmonary autonomic nervous system leads one to the conclusion that such a system, if present, is weak in its action.

The treatment of patients suffering from pulmonary embolism is unsatisfactory. No one knows what percentage of these patients will recover spontaneously. Embolectomy occasionally has been performed successfully in the Scandinavian countries but so far no successful case has been reported in the United States. The size and position of the embolus probably has much to do with the outcome. The so called "rider" embolus projecting into both main branches of the pulmonary artery is rapidly fatal unless immediate embolectomy is done. Smaller emboli lodging in branches of the pulmonary artery are not necessarily fatal, even though branches of both right and left pulmonary arteries may be involved. Operation in some of these latter cases may substitute a fatality for a spontaneous recovery.

Experimental studies on the effects of eupaverine have been meager, especially in the United States. It, therefore, seemed desirable

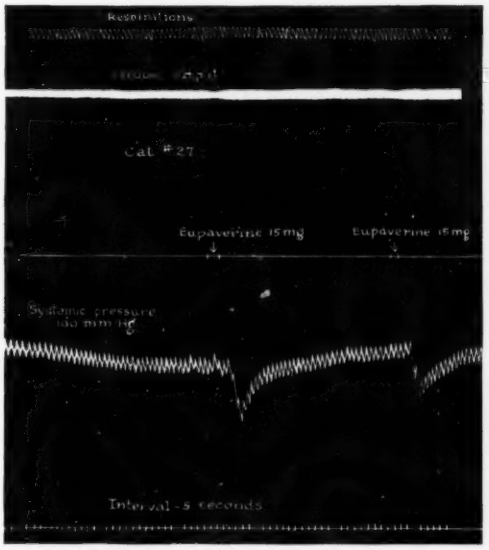

Fig. 2. Effects of eupaverine on respirations, cardiac output, and systemic blood pressure.

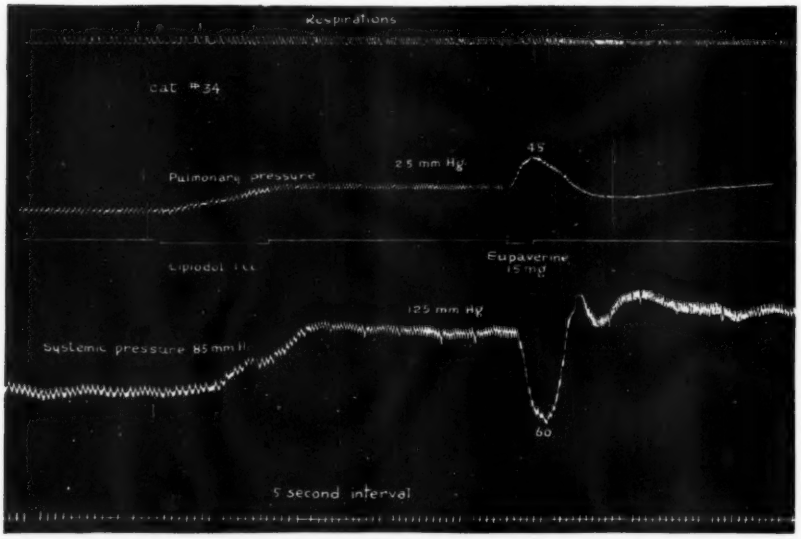

Fig. 3. Effects of lipiodol, followed by eupaverine on respirations, pulmonary and systemic blood pressures.

to make certain observations of the effects of eupaverine in normal animals and on animals with artificially induced pulmonary emboli.

Method and procedures. Cats of 3 kilogram average weight, anesthetized by the intraperitoneal injection of 6 cubic centimeters of a 1:10 sodium barbital solution per kilogram were used in all experiments. The animals were prepared according to the method of Drinker in which the anterior chest plate is removed, the pericardium opened and sutured to the chest wall, thus allowing the lungs to function normally in a closed pleural cavity and permitting free access to the heart and great vessels. Recordings were made of pulmonary arterial blood pressure, systemic blood pressure, cardiac output, and respiratory rate and volume. Systemic blood pressure was recorded directly on a mercury manometer connected to a cannula in the carotid artery. Pulmonary arterial pressure was recorded directly on a mercury manometer connected to a specially devised cannula in the main trunk of the pulmonary artery. Respirations were recorded through a simple chest respirometer, giving frequency and comparative amplitude of respirations. Changes in cardiac output were determined by the use of a bell cardiometer. The soluble bisulphate of eupaverine was the drug used. An average dose of 3 milligrams per kilogram was used.

Twenty-nine animals were used in this series of experiments. Pulmonary pressure was recorded in 24, systemic pressure in all, respirations in 14, and cardiac output in 8. Artificial pulmonary emboli were produced in 24 animals by the intravenous injection of sterile mineral oil, and the effects of eupaverine, both before and after emboli were induced, were studied in 15.

1. EFFECTS OF OIL EMBOLI ON PULMONARY AND SYSTEMIC PRESSURES, RESPIRATIONS, AND CARDIAC OUTPUT

The average pulmonary arterial pressure at the start of the experiments was 12.5 millimeters of mercury and the average systemic arterial pressure was 94.5.

It was found that an injection of oil of 1 to 2 cubic centimeters permitted survival of the animal whereas 3 cubic centimeters usually resulted in death within a few moments. Therefore, 1.5 cubic centimeters of oil was the

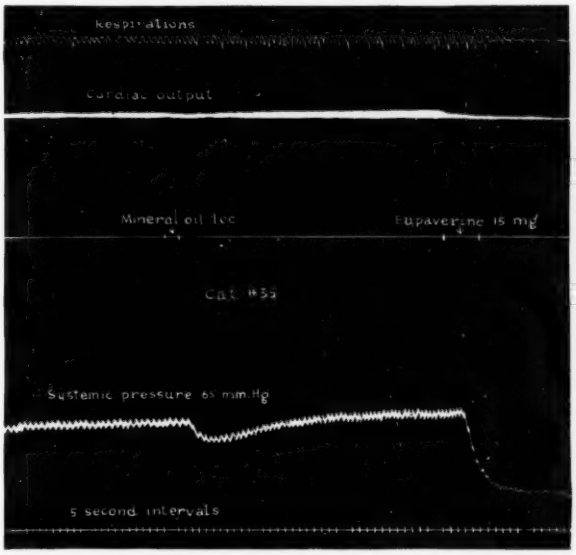

Fig. 4. Effects of mineral oil followed by eupaverine on respirations, cardiac output, and systemic blood pressure.

usual dose given. It was found that within 20 seconds of the injection of the oil into the femoral vein there was an average rise of pulmonary blood pressure of 28 millimeters of mercury which within 2 minutes fell to an average of 15 millimeters of mercury above the original level. At the same time there was a fall in the systemic blood pressure of 13 millimeters of mercury which then rose to a level of 8 millimeters of mercury higher than the original level.

A dose of 1.5 cubic centimeters of oil caused the respirations to increase from 19 per minute to 26 per minute. The majority of the animals showed changes in amplitude of respiration and irregularities in rate.

Cardiac output was decreased 30 per cent immediately after the intravenous injection of oil. After a few moments the cardiac output returned to 2 per cent above previous level.

2. EFFECTS OF EUPAVERINE ON PULMONARY AND SYSTEMIC PRESSURES, RESPIRATIONS, AND CARDIAC OUTPUT

After an intravenous injection of 3 milligrams of eupaverine per kilogram the pulmonary blood pressure rose immediately in all animals, the average rise being 5.5 millimeters of mercury which in a few moments fell to 2.5 millimeters of mercury above the original level.

The systemic pressure fell immediately in all animals, the mean fall being 24 millimeters of mercury which promptly rose to 5 millimeters of mercury above the original level.

Three milligrams per kilogram of eupaverine had practically no effect on respirations except for a slight increase in amplitude.

Three milligrams of eupaverine per kilogram caused an immediate decrease in the cardiac output averaging 15 per cent of the original. This was followed shortly by an increase to a level of 6 per cent above the original.

3. EFFECTS OF EUPAVERINE ON PULMONARY AND SYSTEMIC PRESSURES, RESPIRATIONS, AND CARDIAC OUTPUT AFTER INJECTION OF OIL

When 3 milligrams of eupaverine per kilogram were given to animals after pulmonary embolization with oil there was an immediate

rise in pulmonary pressure averaging 17.5 millimeters of mercury which soon fell to a level of 8.5 millimeters of mercury above the original level.

The systemic pressure fell; the fall averaged 53.5 millimeters of mercury which soon returned to a level of 13 millimeters of mercury higher than the original level.

In 3 animals the injection of eupaverine was followed immediately by a rapid fall in both pulmonary and systemic pressures and death occurred almost immediately; respirations ceased before heart action stopped.

Cardiac output decreased at an average of 40 per cent in these animals and returned to the original level in those animals that survived.

SUMMARY AND CONCLUSIONS

Eupaverine was found to have an immediate effect in lowering systemic blood pressure. This effect was extremely transient and was followed by a slight increase in the blood pressure over the original level. However, in the pulmonary circuit the effect of eupaverine regularly was to cause marked increase in the blood pressure over the original level. When eupaverine was given after oil emboli the effects were qualitatively the same, increased pulmonary pressure and decreased systemic pressure. However, some of the animals failed to survive after oil followed by eupaverine. In view of these results it is difficult to understand how eupaverine could favorably influence the course of either pulmonary or systemic emboli.

Eupaverine has certain spasmolytic actions causing a marked, though transient, fall in systemic blood pressure. Previous investigators have shown that this is probably due to the action directly on the smooth muscle of the vessel wall.

Eupaverine does not lower, but raises, the pulmonary arterial pressure in cats.

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CONCEPTS OF A NEW CLASSIFICATION OF OVARIAN TUMORS

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CLASSIFICATIONS of tumors of most organs in the body have been established, accepted, and utilized by pathologists of the entire universe. However, the classification of ovarian tumors has remained an unsatisfactory chapter of pathology ever since systematic investigation started in the field of oncology. The reason for this lies in the fact that ovarian tumors, to a great extent, consist of tissues definitely different from those of the normal ovary, whereas, in the other organs the structure of the tumors duplicates the normal constituents of the organs from which they arise. Thus, the muscle gives origin to the myoma, the fibrous tissue to the fibroma, the nervous tissue to the neuroma, etc. The classification of such tumors (myoma, fibroma, neuroma, etc.) becomes a matter of fact, since the analogy of such a tumor and the normal tissue permits directly the tracing back to the tissue from which the tumor originated. On the other hand, the ovary is a playground or a resting place for a variety of tumors consisting of tissue elements which are normally not found in the ovary. Such tumors in the scientific terminology are characterized as heterologic, or better, as heterotopic. Prior to 15 or 20 years ago, there was no possibility of giving a satisfactory explanation for the origin of most of these tumors. Since the histogenesis of ovarian tumors was not known, a histogenetic classification was impossible. Consequently, the purely morphological and in some cases the histogenetic system of classification which was available and utilized for the tumors of other organs did not exist for those of the ovary. Substitutions for this type of classification were made by vague clinical or physiological conceptions, with the result that each pathologist had his own classification and there existed no generally accepted system. This made the study of ovarian tumors most difficult for the student for it was necessary for him to familiarize himself with a new classification every time he read a new book or article pertaining to ovarian tumors.

A relatively satisfactory classification was formulated by Pfannenstiel who, in 1906, wrote the chapter on ovarian tumors in the Veit's textbook on obstetrics and gynecology Pfannenstiel succeeded in establishing a certain harmony between the clinical and pathological findings and thus his presentation of ovarian tumors based on the knowledge of the ovary available at that time was the best then obtainable. Approximately 20 years later, when pathologists and gynecologists again attempted to give a complete survey of ovarian tumors, they faced the great difficulty of placing into Pfannenstiel's system the variety of ovarian tumors which had been discovered and investigated since Pfannenstiel's time. The ovarian tumors had been thoroughly investigated from the clinical and morphological points of view but the histogenesis of most of them was still unknown; consequently, a histogenetic classification could not be established.

Most of the existing presentations lack the unity or the continuity of the original principle of classification and utilize other principles which the science of logic has proved to be fundamentally erroneous in any classification. Thus, Sternberg for instance, in 1926 uses as co-ordinated groups: (a) histioid tumors, with fibroma and sarcoma; (b) a group which has no common name but which consists of endothelioma, perithelioma, and cylindroma[1]; (c) cysts and epithelial tumors, which group, among others, contains the Krukenberg tumors which do not originate

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[1] It must be here mentioned that the cylindroma is not an entity but a special type of degeneration found in histioid as well as epithelial tumors. This latter possibility is in contradiction to the grouping of cylindromas under the heading (subordinated group) of histioid tumors.

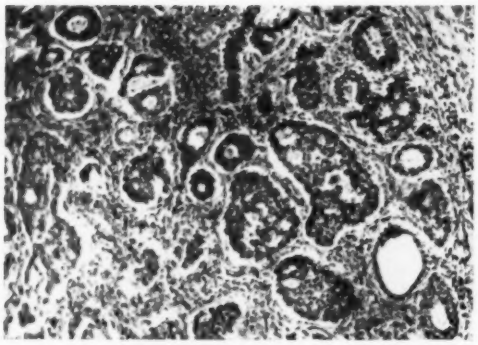

Fig. 1. Granulosa cell tumor, benign. Highest maturity, folliculoma: epithelial islands with suture follicular cavities. Call—Exner bodies.

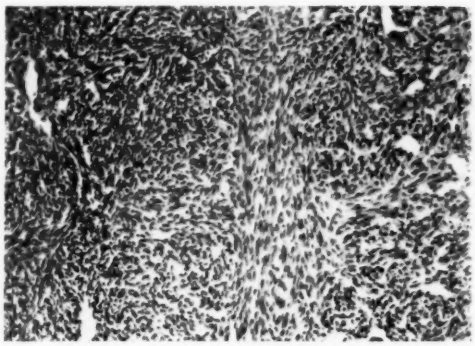

Fig. 2. Fibroma—specific type, benign. The cells are loaded with little fat droplets. Xanthofibroma. Loeffler—Priesel.

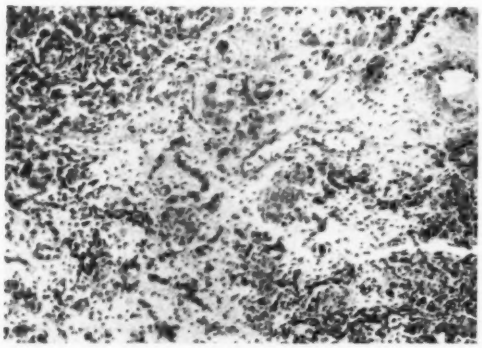

Fig. 3. Arrhenoblastoma, benign. Short trabecula, clusters of pale polyhedral Leydig cells between.

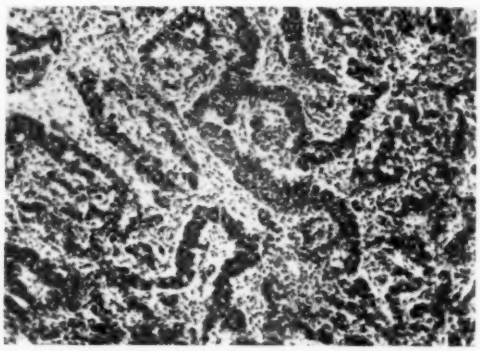

Fig. 4. Arrhenoblastoma, benign. Trabecular type.

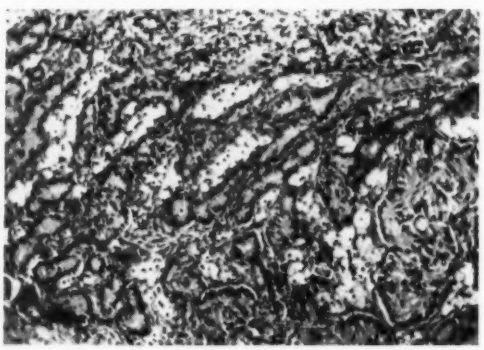

Fig. 5. Arrhenoblastoma—mature type, benign. Adenoma testiculare, Pick. Glandular ducts corresponding to seminiferous ducts. Islands of pale fatty Leydig cells between.

from the ovary itself, and corpus luteum cysts, which are not tumors in the sense of new-growths.

Kermauner, in a brilliant contribution in Veit's *Handbuch der Gynaekologie*, gave a most valuable detailed description of the various ovarian tumors but, as I know from personal communication, never attempted to establish a satisfactory classification. When he began to revise his findings from the point of view of the new embryological discoveries of the ovary, he passed away. Miller, in the most complete presentation of ovarian pathology which exists, in the third part of Volume 7 of the Henke-Lubarsch textbook, uses a very complicated system of classification in which morphological, clinical, and physiological criteria are all utilized simultaneously. The re-

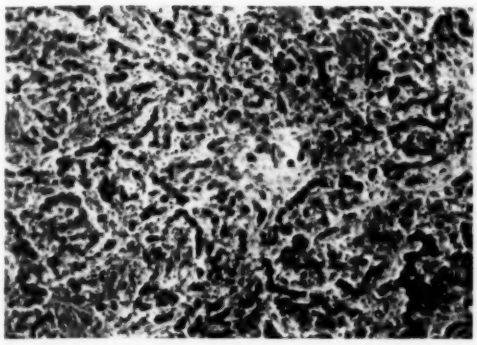

Fig. 6. Dysgerminoma, benign. Rows of single cell breadth.

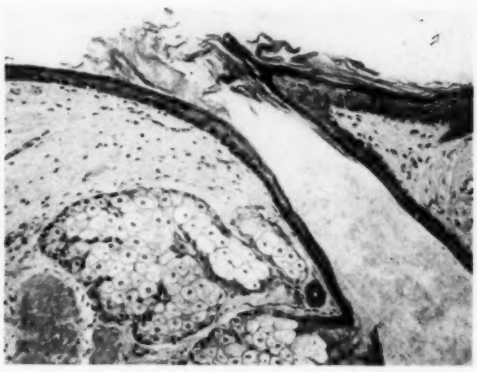

Fig. 7. Dermoid, skin with sebaceous glands, benign. Basal layer of epithelium loaded with pigment (colored patient).

sult of such a classification is that the same tumor appears in different groups or headings —an error which the science of logic teaches should never occur in a well founded classification. Thus, for example, the tubular adenoma appears first under the heading of epithelial tumors and, second, under the heading of virilizing ovarian tumors. The tubular adenomas are both epithelial and virilizing at the same time but two characteristics which can be present in the same unit should not be utilized as co-ordinated headings in any classification. Conill, of Barcelona, in a complete resignation of giving anatomical foundations suggested a half clinical and a half morphological system of classification founded on four disparate characteristics: cystic, vegetative, solid, and hormonic. Three French authors, R. Leroux, J. Levret, and Weinrott, established an anatomical classification which is limited to the epithelial tumors only. A suggestion of a working classification of adenexal cysts and neoplasms has been published by Counseller and Broders which is meant to serve for clinical purposes. It probably will serve this function very well, but for the pathologist it is unsatisfactory because the first group—cysts—includes cysts of corpus luteum which are only the pathological dilatation of a physiological cavity, dermoid cysts, which are true neoplasms, and it separates the latter from teratomas which are found in the classification under B, neoplasms; 2, malignant; f, teratoma.

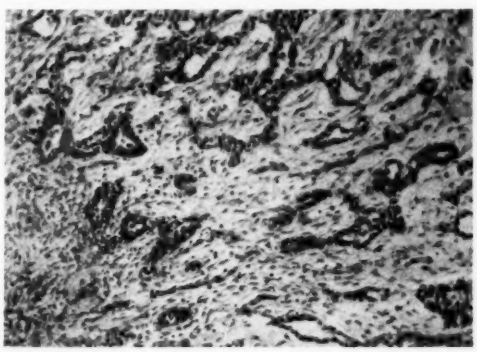

Fig. 8. Teratoma of immature type—embryoma, malignant. Loose mesenchymatous and epithelial adenomatous elements.

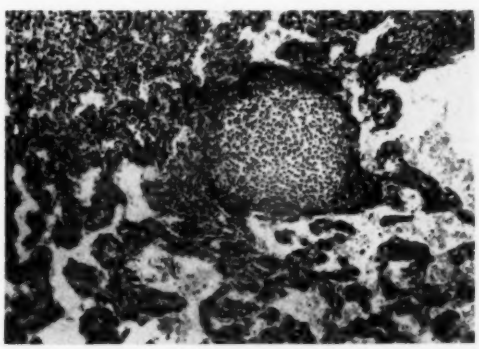

Fig. 9. Teratoma, malignant. Immature type: embryoma. Round islands of cartilage surrounded by venous sinusoids, hemangioma venosum.

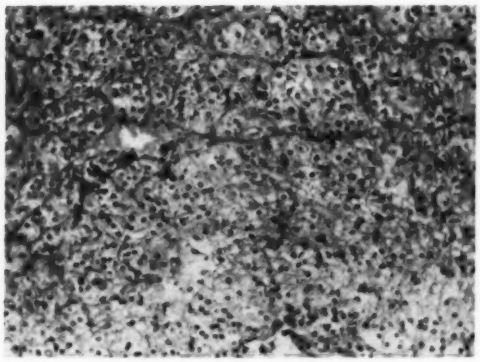

Fig. 10. Hypernephroma, benign. Solid, without hormone production. Not masculinizing.

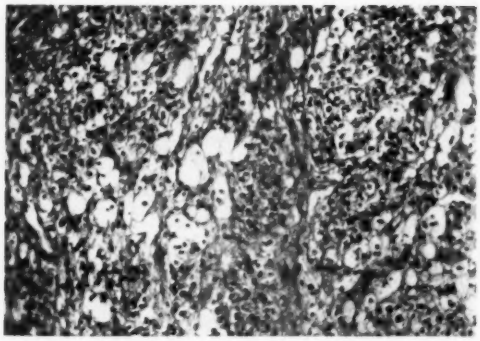

Fig. 11. Hypernephroma, benign. Massive, specific, masculinizing. The cellular elements vary from dark fetal type to pale lipoid laden mature protoplasma.

In Curtis' textbook on obstetrics and gynecology, Goodall gives a very detailed presentation of ovarian tumors, using for the classification, the embryogenesis of the ovary. Unfortunately, at that time, the new discoveries concerning the embryology of the ovary by Fischel and Gruenwald were not known and consequently Goodall used the old theory which traces all the epithelial structures of the ovary to the surface epithelium. This theory has since been discarded and, as it is incorrect, it could not be instrumental in explaining the histogenesis of ovarian tumors.

R. T. Frank, in 1931, discussed the various classifications suggested up to this time and chooses for his work a simple modification of the Pfannenstiel-Sternberg classification. He divides the tumors of the ovary into epithelial tumors, connective tissue tumors, and mixed tumors (embryomas). This is a grouping rather than a classification of ovarian tumors but it does give justice to the great variety of structure and the histogenesis of the ovarian tumor. Ewing, in his famous monograph on tumors, similarly does not attempt to give a classification but merely an enumeration of ovarian tumors. The same is true for Pomeroy, of Cleveland, who merely enumerates 14 different types of ovarian tumors without superordinated or subordinated division. Likewise, the *Pathological Index* of the American Medical Association lists numerous ovarian tumors in no particular order.

When we attempt to establish a histogenetic system and classification of ovarian tumors, one test for its working capacity is whether

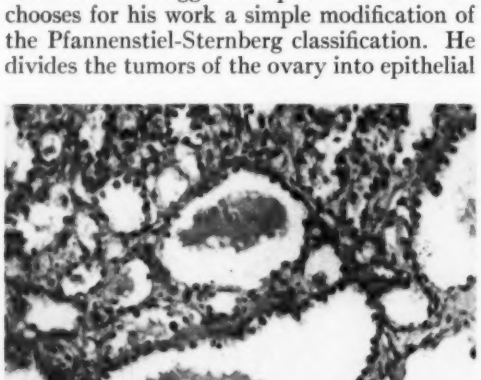

Fig. 12. Mesonephroma, benign. Cystic type. The cavities lined with hobnail shaped endothelium-like cells.

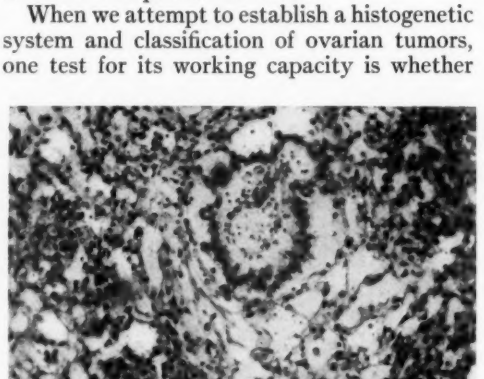

Fig. 13. Mesonephroma, malignant. Pseudoglomerulus in the center.

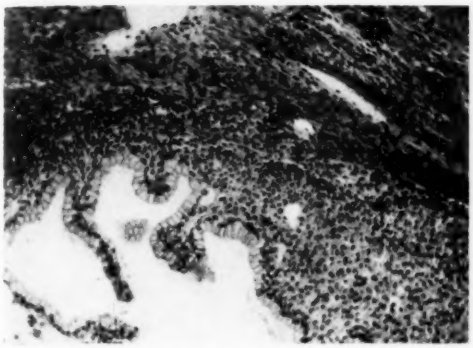

Fig. 14. Brenner tumor, benign. The glandular part is well developed.

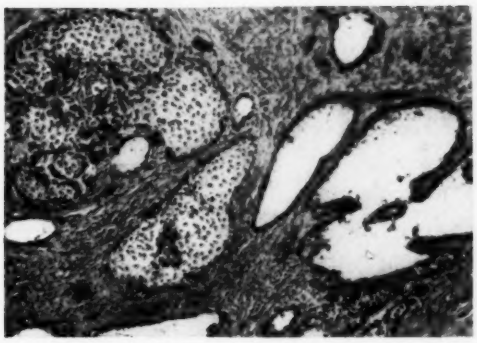

Fig. 15. Brenner tumor, benign. The epithelial islands with cystic degeneration.

the great number of the so called rare ovarian tumors recently discovered and investigated (dysgerminoma, Brenner tumor, arrhenoblastoma, etc.) can be placed into the system without disrupting the system or the conception of the tumor. According to the laws of logic, no tumor should appear under different headings in the same classification. This, of course, does not mean that we can avoid putting tumors which are clinically and morphologically almost identical into two different groups according to the histogenesis. For instance, there are two different types of pseudomucinous cystoma from the histogenetic viewpoint, but which clinically and even histologically are almost identical. One develops from the prosoplastic surface epithelium and the other represents the intestinal part of a teratoma. The histogenetic classification has to place these two tumors in different groups. This does not weaken the histogenetic system for it is very probable that, with increasing knowledge and experience, tumors of different histogenetic origin may prove to be clinically different especially with regard to the tendency of malignant degeneration.

The first group is represented by pathological changes which the clinician is prone to call tumors, meaning thereby, enlargement of the organs as indicated by palpation. This enlargement, however, is not the result of neoplastic transformation. This group is represented by cysts which signify dilatation of physiological cavities by retention of secretion. This term, "cyst," must never be confused with the term "cystoma" for the suffix "oma" means a real tumor, analogous to a lipoma, neuroma, fibroma, etc. Whenever the diagnosis of a cyst is made, one must trace back its origin to a physiological cavity which has given rise to a cyst as a result of retention of its secretion. In the ovary there are three types of cavities which may become cystic by storing pathological amounts of fluid: the follicle, the corpus luteum, and the corpus atreticum. These result in follicular cysts, corpus luteum cysts, and corpus atreticum cysts. The latter arise from corpora atretica with luteinized theca which are generally found only in pregnancy. These cysts may give rise to the well known bodies, having a yellow wall with a red center which compose the enlarged ovary in hydatid moles and chori-

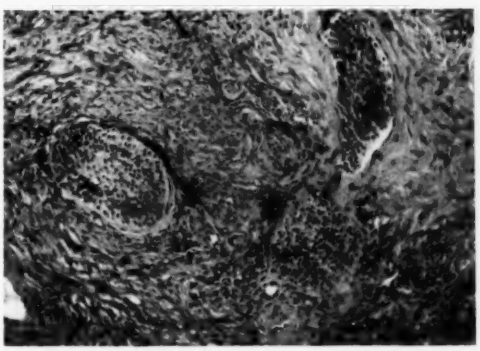

Fig. 16. Brenner tumor, benign. Epithelial islands without glandular inclusions. The surrounding fibromatous tissue presents hyaline degeneration.

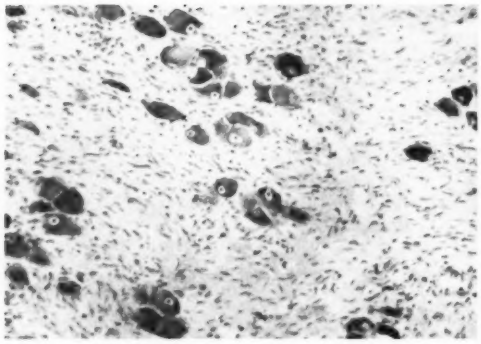

Fig. 17. Solid ganglioneuroma of the ovary, benign.

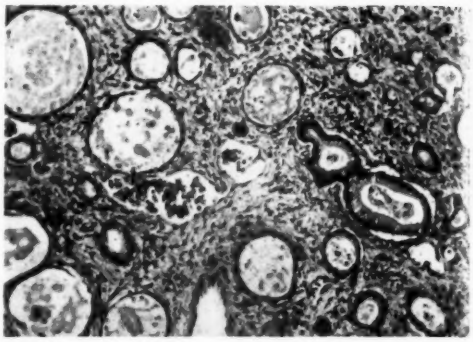

Fig. 18. Krukenberg tumor, malignant. Cystic deposits—right side from the center, a glandular formation; left side from the center, a lymph vessel with free floating signet ring cells.

onic epitheliomas, as a result of hyperhormonic secretion, i.e. by an abundance of prolan B, with secondary bleeding in the cavity. The correct and accurate name for these would be luteinized corpora atretica cysts, but this has been replaced by the term lutein cysts as suggested by the first investigators.

The true ovarian neoplasms must be divided according to the origin of the tissues which would place them into two groups. The first group consists of tumors developing from tissue which is found in the normal physiological ovary. These tumors, inasmuch as they arise from the ovary itself, can be called "ovariogenic." This group is represented by two members, both developing from the mesenchymatous core of the ovary. The first is the granulosa cell tumor which develops from fetal remnants of the tissue which physiologically develops into granulosa. Thus the tumor duplicates the embryological development of the granulosa. It can be subdivided according to the analogy with the fetal development of the follicles as: (a) homogeneous immature, corresponding to the phase before the development of the germinal cords and thus similar to an immature fibroma; (b) trabeculated, corresponding to the phase of germinal cords; and (c) imitating the mature follicle, called mature folliculoid or folliculoma. The second tumor corresponds to the unspecific component of the mesenchymatous core which normally furnishes the interstitial fibrous stroma. This tumor is the fibroma, with a subgroup characterized by luteinization—the so called xanthofibroma theca-cellulare of Loeffler-Priesel.

The second group of ovarian tumors develops from tissue which is not found in the normal ovary but is found elsewhere. An adequate name for these tumors would be "heterotopic"—which is the verbal Greek translation of "other places." I prefer the name, "heterotopic" to "heterogenetic" which would mean neoplasms developing elsewhere and would not include tumors of non-ovarian type which develop from ovarian constituents. The heterotopic tumors can be divided into two subgroups. First, those tumors which may adequately be placed in the group classified by the heading "Errors in Differentiation" for they arise from constituents of the ovary which, as a result of failure of differentiation, develop into non-ovarian tissues. Second, those tumors which consist of non-ovarian tissue which was shifted into the ovary as a result of pathological changes. This shifting of non-ovarian tissue into the ovary may occur during fetal time, by developmental error or in adulthood, by either surface implantation of normal tissue or metastases of neoplastic tissue. The group of pathological differentiation can again be subdivided into two groups according to the origin of the error in differentiation. This error may occur in the surface epithelium which was formerly called germinal epithelium—a name which arose from the misconception that this epithelium produces

oogonia and spermatogonia, i.e. it produces the germinal cell. Since we know today, as a result of the discovery of the germinal route that the germinal cells arise from the posterior wall of the primitive gut and enter the developing ovary from the back or dorsal side, from its hilum, there is no justification for calling the surface epithelium the germinal epithelium. The latter is a part of the celomic epithelium and, therefore, has the same origin as the epithelium which situated at the lateral pole of the gonad by invagination and inclusion forms the muellerian duct. This muellerian epithelium, later by differentiation, develops into high columnar ciliated, or serous epithelium of the tube, into the glandular epithelium of the cavity of the uterus and into the high pale mucinous epithelium of the cervical canal. Ovarian epithelium, frequently, as described for the first time by Walthard, invaginates and forms by separation from the surface, the so called Walthard cysts. These little cysts may give origin to cystomas later or even to neoplastic proliferation by differentiation of the epithelium. The differentiation may parallel the potentialities of the muellerian duct. (Formerly this would be explained by the conception that muellerian cells were misplaced medially on the surface of the ovary. Today, however, we discard this primitive mechanical conception and prefer the statement that in the early stages of development, cells possess almost every prospective potentiality and that these potentialities decrease gradually as development and differentiation take place, with the exception of the one that harmonizes with the localization of the cell. In the case of the aforementioned cysts, the developmental error consists in the fact that one of these potentialities is not extinguished). If the inclusion cyst duplicates tubal development, it forms a serous ciliated cystoma. If it duplicates endometrium, an endometrioma is formed. If it duplicates cervical epithelium, a pseudomucinous cystoma is formed. The similarity of the tubal epithelium and the serous cystoma has been known for a long time and has been investigated accurately by cytologists and recently emphasized by Russian authors. The analogy between endometrium and endometrioma is responsible for the name of this tumor. Endometriomas of this origin have to be traced back to the adenoserositis of Rob. Meyer and separated from the implantation endometriomas of Sampson. The similarity between the epithelium of pseudomucinous cystomas and cervix has puzzled many investigators. Even the unjustifiable theory of an implantation of tissue arising from a cervical menstruation which does not exist has been offered as an explanation. The difference between mucinous and pseudomucinous secretion which was stated in old times, based on the presence or absence of coagulability by alcohol is not justifiable, for today we know that as a result of changes in the colloidal phase, the coagulability with alcohol decreases with increasing age of the mucin.

The cystomas, especially the serous and the mucinous, could be characterized by two more descriptive attributes: unilocular or multilocular and simple or papillomatous. Very frequently, the tendency to form papillomatous projections in the serous cystoma arises, not only in the depth, that is, in the wall of the cyst, but simultaneously in the surface epithelium, thus giving origin to superficial papillomatous projections. When only the surface epithelium develops into papillomatous projections, we see a surface papilloma which in the classification has to be co-ordinated with the papillomatous cystoma. Combination of serous cystoma with surface papilloma and fibroma (by fibromatous thickening of the septa) is not too rare: papillomatous cystofibroma or fibrocystoma.

A second possibility giving rise to the second group of tumors resulting from an error in differentiation develops from the depth and not from the surface of the organ (i.e. it arises from the mesenchymatous core). The cells of this tissue partially give origin to the unspecific interstitial tissue of the ovary and partially contribute to the formation of the germinal cords by furnishing the auxilliary cells which serve to build the follicle and later become transformed into granulosa cells—as Fischel has definitely proved. It may happen that one of these cells during mitotic division loses one X chromosome and so becomes male in character. Such a cell has the tendency and

potency of the mesenchymal core of the testicle as a fetal remnant and, developing in a neoplasm, it gives origin to a tumor which duplicates the fetal development of the testicles but without spermatogonia. This tumor, likewise, has three phases: (a) homogeneous immature; (b) trabecular, like male germinal cords; (c) adenomatous—duplicating mature testicular ducts as adenoma testiculare. This tumor, like fetal testicle, contains a great number of interstitial Leydig cells which produce a male hormone and consequently may have a masculinizing effect on the bearer. It is called arrhenoblastoma.

A third possibility arises when, as a result of developmental error in the sex chromosomes, the type and mechanism of which error we do not understand nor know as yet, the cells develop in neither adequate male nor female direction but become sexually indifferent or neutral. This error occurs in the ovary as well as in the testicle and very characteristically in high incidence in hermaphroditic gonads which probably develop a neutral zone between the zones of different sexes. Consequently, this tumor develops identically in ovaries, testicles, and hermaphroditic gonads. It consists of large round cells with a pale, delicate protoplasm arranged in alveoli between connective tissue septa or in rows between connective tissue fibers. Formerly this tumor was described as a large cellular carcinoma or sarcoma. It was not until the French investigator, Chevassu found it in the testicle and traced it back to the spermatogonia that it was called a seminoma. Rob. Meyer stressed the fact that the ovarian dysgerminoma never masculinizes the bearer and produces no hormones. He also suggested the name "disgerminoma" to show that the tumor develops from both—"dis"—gonads or germinal glands (and not "dysgerminoma" from "dys" meaning wrong, as for example, in dysmenorrhea). The dysgerminoma has a great tendency to disintegrate and to undergo fatty degeneration. The stroma responds to the fatty products of degeneration by producing granulation tissue consisting of lymphocytes, epitheloid cells, giant cells of the Langhans type—thus duplicating tuberculous granulation tissue. This coincidence in many cases, is responsible for the mistake made by some observers who stated a coincidence of dysgerminoma and tuberculosis.

The tumors developing from misplaced tissue contain as the first group those arising from displacement of cells during fetal time. These cells have multiple potencies and are called blastomeres by embryologists. When they develop into tumors, they give rise to a poorly organized mixture of tissues called teratomas. Formerly, the word teratoma was used to include the attribute of malignancy. This is not justifiable for benign teratomas undoubtedly exist. The term itself means a tumor composed of tissue, the presence of which in this locality, the observer considers a miracle. It is better to use the word teratoma without anticipating its clinical evaluation and to add the attribute, benign or malignant. The most frequent example of the mature teratoma is the dermoid. The immature teratomas, whose tissues do not surpass the limit of fetal differentiation are called embryomas. Further classification of teratomas can be given by the origin of the tissues they contain: monophylloma—when the tumor consists of tissue of one germinal layer only, diphylloma or triphylloma when it consists of tissues of two or three germinal layers. The displacement of cells may occur at a much later phase of embryonic life—at a time when the cells have already acquired a definite differentiation. At that time it may occur that cells of organs which develop in the vicinity of the ovary are displaced in the field of the ovarian parenchyma. Inasmuch as the ovarian pedicle develops comparatively late, the ovary remains in close connection with other tissues for a long period. Gradually, however, it becomes separated from the surrounding tissues by the formation of two folds or grooves which enclose the ovarian ligament. If these two folds cut in too deeply or too far from each other, they may add extra-ovarian tissue to the ovarian stock. This explains the origin of the mesonephroma which presents mesonephromatous tissue. Frequently, the hilum of the ovary contains little islands of suprarenal cortical tissue. The fact that such islands are much more frequently encountered in the newborn than in

the adult, proves that they generally disappear by involution. If they persist and give origin to tumors, hypernephromas arise. The Brenner tumor consists of islands of transitional squamous epithelium which are embedded in a fibromatous stroma and may enclose glandular cavities lined with high columnar, mucinous epithelium. The combination of intraepithelial glands (i. e. mucinous glands embedded in stratified epithelium) is characteristic for the neighboring uropoietic system and is found physiologically in the pelvis of the kidney and in the urethra. The fibromatous component is only a secondary response of the surrounding stroma. When from the neighboring sympathetic ganglia elements are encased in the ovarian tissue, ganglioneuromas may develop.

Implantation in the adult can be found under two entirely different conditions. Thus, carcinoma cells arising from the mucous membranes of the abdominal cavity, most frequently from the stomach, then small or large intestines, gall bladder, or pancreas, may be grafted to the ovarian surface via the lymph vessels from the side of the hilum or from the surface. They give rise to metastatic carcinomas, formerly called Krukenberg tumors in spite of the fact that Marchand and not Krukenberg first described them.

Implantation of endometrium by retrogressive menstruation through the fallopian tube has been described by Sampson as giving rise to ovarian endometriomas. This type of endometrioma is histogenetically but not morphologically different from the prosoplastic endometrioma here described. Once a certain stage of development and size has been reached, the two endometriomas may look identical.

With exception of the metastatic Krukenberg carcinoma, this classification mentions no malignancies—neither carcinomas nor sarcomas. This is entirely opposed to other systems of classification which classify certain groups as malignant by themselves. Kermauner, for instance, includes in his book a group called "granulosa cell carcinomas." By so doing, he denies the existence of benign granulosa cell tumors. In general, the older systems, distinguish so called primary carcinomas of the ovary, i.e., tumors which originally began as malignancies, and secondary carcinomas of the ovary, i.e., tumors which originally began as benign tumors but which underwent malignant degeneration thus becoming malignant—and not metastases in the sense that the word secondaries is generally used.

Concerning the first group, the primary carcinoma, which starts out as such, a critical consideration raises certain doubts. Thus, we have very accurate knowledge of beginning carcinomas of the skin and of the cervix uteri many of which are smaller than 1 millimeter

CLASSIFICATION OF OVARIAN TUMORS

Cysts

a. Follicular
b. Corpus luteum
c. Corpus atreticum, luteinized—lutein cysts.

True tumors

A. Ovariogenic—derived from ovarian tissue
  a. Granulosa cell tumor
    I. Homogeneous
    II. Trabeculated
    III. Follicular
  b. Fibroma
    I. Simple
    II. Luteinized—xanthofibroma thecacellulare
  c. Myoma, angioma, luteinoma
B. Heterotopic—derived from tissue not normally present in ovary
  a. By pathological differentiation
    I. From surface epithelium—prosoplasia in direction of muellerian duct
      1. Serous cystoma—tube
      2. Endometrioma—endometrium
      3. Pseudomucinous cystoma—cervix
    II. From mesenchymal core by error in sex chromosomes
      1. Arrhenoblastoma—male
      2. Dysgerminoma—neutral
  b. From displaced tissue
    I. In fetal life
      1. Early—teratoma
        Mature—dermoid, e.g.
        Immature—embryoma
      2. Late—tissue from vicinity
        Ganglioneuroma
        Hypernephroma
        Mesonephroma
        Brenner's tumor—urogenital epithelium
    II. In adult life
      1. By implantation—endometrioma
      2. By metastases of malignant tumors—Krukenberg carcinoma, e.g.

The cystomas of B, a, I, 1–3 are to be characterized as unilocular or multilocular, and as simple or papillomatous.
The surface papilloma may be classified under B, a, I, 1, papillomatous, the folliculoma lipidique Lecène tentatively under A, a, the myxoma under B, b, I, 1.
The arrhenoblastoma of B, a, II, 1, may be characterized as homogeneous, trabeculated or adenomatous-testicular.

in diameter. Numerous of these cases have been found accidentally by investigators while examining supposedly normal organs. In the cervix uteri, the probability of encountering a small, beginning, clinically latent carcinoma during the examination of a supposedly normal organ is as Smith and Pemberton and I have found, about 2 to 3%. No small carcinoma of the ovary is described in the literature. Many thousands of so called normal ovaries have been examined carefully by gynecologists, histologists, and pathologists throughout the world. I have carried out systematic examinations along these lines for many years but never have I nor anyone else discovered a small beginning carcinoma of the ovary. A few cases of pea-sized granulosa cell tumors have been found and some of these have been described even as beginning malignancies, but this error was made as a result of the same mistake which caused granulosa cell tumors to be diagnosed as malignant entities. I have had the opportunity to find and to examine several of these small granulosa cell "carcinoma germs." They all showed the same cell character which the larger benign granulosa cell tumors present. Neither polymorphous nor atypical cells were seen, thus proving themselves to be young, immature, but not malignant growths. Evidently no small ovarian carcinoma a few millimeters in size exists, for if it did, it could not have escaped and at least 1 or 2 cases would have been discovered as a result of the careful examination of thousands of slides by experts throughout the world.

The conclusion which we are compelled to draw from this fact is that carcinoma of the ovary does not originate in this way. It probably does not originate primarily from a carcinomatous germ which is analogous in its cells to the progressed carcinoma but by malignant degeneration of benign neoplasms. This conception is supported by the finding of progressed benign ovarian neoplasms with partial malignant degeneration as has been found by several observers. We must therefore add to each of the primarily benign group of our classification the corresponding malignancy developing by secondary malignant degeneration of the primary benign neoplasma. Thus, for example, we have adenopapillary cystoma and adenopapillary carcinoma; fibroma and sarcoma; teratoma and teratoid carcinoma, sarcoma or sarcocarcinoma, the type of malignancy corresponding to the tissue of which the benign tumor consists. Generally, accurate examination of several slides from several parts of a tumor presents portions which permit by transitions the tracing back of the malignant to one of the benign tumors. Sometimes in some malignant tumors degeneration and dedifferentiation has gone too far to permit this tracing back of the carcinoma to a special type of benign tumor. In such cases, of course, classification is not possible. All we can do is to describe the tumor and register it, for instance as a nondescript solid carcinoma of alveolar structure with polyhedral cells and irregularly shaped hyperchromatic nuclei.

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THE TREATMENT OF SPONTANEOUS, THREATENED, OR HABITUAL ABORTION

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THE advisability of attempting to arrest the progress of a threatened abortion might be disputed on the grounds that one is apt to deliver a malformed fetus if success is attained and the patient carried to term. That this risk is more theoretical than real is shown by Shute (20) who has collected the data in the literature on fetuses delivered after threatened abortion had been successfully controlled by means of vitamin E and/or progesterone, and found that of 443 patients so treated only 2 per cent expelled deformed fetuses, concluding "that vitamin E and progesterone may actually facilitate completion of the inadequate development of certain types of defectives if given in time." No tenable argument, however, can be held against any attempt made to carry to term a woman who habitually aborts.

Excellent results have been obtained in cases of threatened or habitual abortions by the use of the anterior pituitary-like hormone (8, 14) or the corpus luteum hormone, progestin (4, 7, 9). The value of thyroid extract in cases of this type has been recorded (10, 11, 12, 13), and recently attention has been directed toward another substance thought to be necessary for the maintenance of gestation, namely, vitamin E. Our results with this substance as a basis for the treatment of threatened or habitual abortion prompted this report.

WHEAT GERM OIL—VITAMIN E

The adverse effect of a lack of vitamin E upon gestation in experimental animals has been well demonstrated (5, 21), and it has been shown that the administration of anterior pituitary or pregnancy urine extracts does not prevent the characteristic resorption of the fetuses of vitamin E deficient rats (3). Other investigators (6) conclude that in vitamin E deficient rats there is pathological development of the embryo and embryonic contributions to the placenta but no pathological change in the uterus or endometrium, and that these changes prevent successful implantation of the ovum; whereas vitamin E administered even as late as a few hours before implantation resulted in normal implantation and gestation. These findings are significant because they indicate that although success is attained in the treatment of threatened or habitual abortion by the use of the anterior pituitary like hormone or progestin, these hormones will not prevent abortion due to a lack of vitamin E. Shute (15, 16) believes that the beneficial results of vitamin E are due to its neutralization of all antiproteolytic ferment found in the blood of women who habitually abort and that vitamin E is anti-estrogenic. The same author has devised a chemical test whereby it is claimed a deficiency of vitamin E can be ascertained (19). Very good results have been reported on the use of vitamin E in the treatment of habitual or threatened abortion by Vogt-Muller, Watson (23), Bishop, Currie, Shute (15–18), Watson and Tew (24).

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PERSONAL OBSERVATIONS

A series of determinations of the antiproteolytic power of blood serum from normal nonpregnant women, normal pregnant women, habitual aborters, and cases of threatened abortion, before and after the administration of wheat germ oil, were performed by us. The method used was that described by Shute (19). Our results were so inconsistent and inconclusive that we have abandoned the use of the test and prescribe wheat germ oil for all cases of habitual and threatened abortion purely because of the good results obtained by other authors and the encouraging results that we have obtained in this series.

TABLE I.—THREATENED ABORTION

Case No.	Name	Age	Para	Gravida	Previous abortion	Bleeding time	Pain	Wheat germ oil	Antuitrin S	Corpus luteum hormone	Thyroid extract	Results
1	F. B.	30	0	1	0	5 wk.	3 da.	yes	1 c.cm.	yes	yes	Pregnant now 5 mo.
2	E. B.	20	0	1	0	4 mo.	1 wk.	yes	yes	yes	yes	Pregnant now 18 wks.
3	B. B.	27	1	2	0	0	3 da.	yes	yes	no	no	Delivered normal term male
4	J. E. C.	26	0	1	0	10 wk.	yes	yes	yes	no	no	Delivered normal term male
5	R. C.	27	1	2	0	no	3½ mo.	yes	no	no	yes	Delivered normal term female
6	C. C.	28	0	1	0	8 wk.	yes	yes	yes	yes	yes	Pregnant now 7 mo.
7	B. E.	22	0	1	0	no	3 mo.	yes	no	no	yes	Delivered normal term male
8	C. F.	27	0	1	0	no	5 mo.	yes	no	no	yes	Delivered term male*
9	H. G.	25	1	2	0	5 mo.	yes	yes	yes	yes	no	Delivered normal term female
10	L. H.	23	0	1	0	8 wk.	yes	yes	yes	yes	no	Delivered normal term male
11	F. L.	26	1	2	0	3½ mo.	yes	yes	yes	yes	no	Delivered normal term male
12	A. L.	25	0	1	0	3 mo.	yes	yes	yes	no	no	Delivered normal term female
13	W. M.	21	0	1	0	6 wk.	yes	yes	yes	yes	yes	Delivered normal term male
14	C. P.	29	0	1	0	6 wk. 10 wk.	yes	yes	yes	yes	yes	Delivered normal term female
15	J. S.	24	1	2	0	no	yes	yes	yes	no	no	Delivered normal term female
16	E. V.	24	1	2	0	6 wk. 11 wk.	no	yes	yes	yes	no	Pregnant now 18 wks.
17	M. W.	17	0	1	0	3 mo.	yes	yes	yes	yes	yes	Delivered normal term male
18	J. G.	24	2	3	0	3 mo.	yes	yes	yes	yes	no	Delivered normal term male
19	H. R.	28	1	2	0	2½ mo.	yes	yes	no	yes	no	Miscarried at 2½ mo.
20	D. D.	26	0	1	0	6 wk.	yes	yes	yes	yes	yes	Miscarried at 8 wks.
21	F. H.	26	1	2	0	3 mo.	yes	yes	yes	yes	no	Miscarried at 3 mo.
22	G. R.	33	2	3	1	3 mo.	yes	yes	no	yes	no	Pregnant now 5 mo.
23	L. S.	26	0	1	0	3 mo.	yes	yes	yes	yes	yes	Pregnant now 5 mo.
24	M. S.	25	0	1	0	6 wk. 4 wk.	no	yes	no	no	yes	Pregnant now 4 mo.

*Mild hypospadias.

We have used wheat germ oil in the treatment of 36 cases of spontaneous, threatened, or habitual abortion in combination with the anterior pituitary like hormone, progesterone, and/or thyroid extract. The wheat germ oil was of the cold pressed type and was never prescribed in more than a 2 ounce quantity. The patient was advised to keep the oil in the refrigerator because of the rapidity with which the oil deteriorates (18). The daily maintenance dose ranged from 1 to 1½ drams unless the patient began to show signs of threatened abortion or showed signs of threatened abortion when first seen. Eight to 12 drams were given during the first 24 hours to these patients as advised by Shute (17), and then the patients were placed on the daily maintenance dose. Oil was given until patients reached 8 to 8½ calendar months of pregnancy.

The anterior pituitary like hormone in the form of antuitrin S was administered intramuscularly in 1 cubic centimeter doses given at weekly intervals until the patient was pregnant 4 to 4½ calendar months. In a few cases injections were continued until the seventh calendar month.

One rabbit unit of progesterone was administered daily intramuscularly when cramping or bleeding was actually present. Upon cessation of these symptoms the corpus luteum hormone was discontinued and antuitrin S substituted.

Thyroid extract in 1/10 to ½ grain doses twice daily was given to all patients showing

TABLE II.—HABITUAL ABORTION

Case No.	Name	Age	Para	Gravida	Previous abortion	Last pregnancy			
						Bleeding	Pain	Therapy	Results
25	C. M.	25	0	3	6 mo. 3 mo.	For 2 wks. at 3 mos.	yes	Antuitrin S Wheat germ oil Corpus luteum hormone	Normal full term male
26	L. C.	30	0	4	6 mo. 3 mo. 6 mo.	no	no	Antuitrin S Wheat germ oil Thyroid extract	Normal full term male
27	E. W.	32	0	3	6 wk. 11 wk.	Twice; 2 das. at 3 and 6 mo.	yes	Antuitrin S, and corpus luteum hormone Wheat germ oil Thyroid extract	Normal full term male
28	M. L.	32	0	3	2½ mo. 2 mo.	no	no	Follutein Wheat germ oil Thyroid extract	Normal full term female
29	C. K.	30	1	3	8 wk.	no	yes 2 days	Antuitrin S Wheat germ oil	Normal full term female. Mild preeclamptic toxemia
30	J. C.	27	0	2	6 wk.	Profuse at 5 mo.	yes	Corpus luteum hormone Wheat germ oil	Miscarried. Was a case of missed abortion
31	M. A.	22	0	2	6 wk.	From 6th to 8th wk.	no	Antuitrin S Wheat germ oil	Normal full term female
32	J. C.	28	0	2	6 mo.	no	yes 3 days	Wheat germ oil Antuitrin S Thyroid extract	Normal full term female
33	C. R.	29	1	3	6 wk.	Profuse at 6 wk.	yes	Corpus luteum hormone Wheat germ oil	Miscarriage at 6 wk. initiated by malarial fever
34	R. S.	26	0	3	7 wk. 12 wk.	For 2 wks at 3½ mo.	yes	Corpus luteum hormone Wheat germ oil Thyroid extract	Miscarriage at 3½ mo.
35	H. T.	25	0	2	8 wk.	For 7 days at 8 wk.	yes	Corpus luteum hormone Wheat germ oil Thyroid extract	Normal full term female
36	H. C.	29	1	3	3 mo.	no	yes 4 days	Corpus luteum hormone Wheat germ oil	Pregnancy now 6½ months

evidence of hypothyroidism, as obesity, irregular menstrual periods, slow pulse, etc. Basal metabolic rates were not taken in all cases.

We have classified our cases as "threatened abortion" if cramping pain in the lower abdomen persisted longer than 24 hours or if a patient had bleeding, whether only spotting or in larger quantities. We were careful to eliminate any bleeding that might arise from an erosion or lesion in the lower genital tract. Cases were classified as "habitual abortion" if the patient had had 2 or more spontaneous abortions or had had 1 previous abortion immediately prior to, or attempted to abort during her present pregnancy.

Twenty-four cases of threatened abortion, including patients under our antepartum care or first seen when attempting to abort, were treated as outlined herein. In 3 of these cases the abortion went to completion despite therapy. Of the remainder, 14 have been delivered of normal, full term children; 1 has now passed the period of viability, and the remainder have retained their pregnancies without further signs or symptoms of abortion. This represents a successful arresting of the abortion in 87 per cent of these cases.[1]

In the habitual abortion group 12 patients were treated and of this number 8 have been delivered of normal, full term, healthy infants, while another is now pregnant 6½ calendar months. Three patients aborted despite treatment. In 1 of these, Case 33, the abortion was precipitated by an attack of malaria. Another, Case 30, was a case of missed abortion, and was not seen until she complained of vaginal bleeding and abdominal cramps. Though the fundus was not as high as it should have been for a 5 months' pregnancy, therapy was instituted. After 10 days of therapy the patient expelled a macerated fetus. These 12 cases, prior to treatment, had a total of 21 pregnan-

[1]Since submitting this article for publication, all patients listed in Table in whom the abortion was successfully combatted have delivered full term normal infants.

cies resulting in only 3 live births. With therapy, the same group, in 12 pregnancies have already been delivered of 8 full term, living children.

ANALYSIS OF RESULTS

We believe that as yet there is no single substance that will consistently prevent spontaneous or habitual abortion, and that a combination of substances of proved value will give the highest percentage of results. Wheat germ oil is used as the basis of treatment in all of our cases with progestin or the anterior pituitary like hormone and/or thyroid extract added when deemed necessary. Though our determinations of the antiproteolytic powers of the blood of women, who are habitual aborters or undergoing spontaneous abortion, before and after the use of wheat germ oil are inconsistent and inconclusive, there are 3 cases in this series that clinically offer a great deal of proof as to the efficacy of wheat germ oil.

Each of these patients, Cases 16, 24, and 27, stopped taking the wheat germ oil of their own accord and even though they were on maintenance doses of thyroid and progestin, they promptly began to attempt to abort a second time during the same pregnancy. Resumption of wheat germ oil therapy was followed by a prompt cessation of bleeding and cramping pain and allowed the pregnancy to proceed with no recurrence of these symptoms.

Of the 22 children delivered from this group only 1 showed any evidence of deformity, and that was a mild hypospadias in the child of Case 8. This deformity is so slight, in fact, that surgical correction will not be necessary.

CONCLUSIONS

1. Wheat germ oil therapy forms a valuable basis for the treatment of spontaneous and/or habitual abortion.

2. Wheat germ oil therapy should be fortified by the administration of progestin and/or thyroid extract when necessary.

3. The fear of delivering a malformed fetus in cases in which spontaneous or habitual abortion has been successfully combatted is overemphasized.

4. All efforts should be made to control spontaneous abortion or habitual abortion by the use of all known remedies which have been proved of value.

5. We present our results in 36 patients so treated to substantiate our views.

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EFFECT OF NITROUS OXIDE OXYGEN ETHER ANESTHESIA UPON OXYGENATION OF MATERNAL AND FETAL BLOOD AT DELIVERY

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In an earlier study (6) data were presented concerning the effect of certain commonly used obstetrical anesthesias upon the maternal and fetal blood at birth. In that report attention was directed particularly to the influence of ether, nitrous oxide, and cyclopropane, each of which was accompanied by rather characteristic changes in blood oxygenation. These may be summarized as follows:

In general, ether anesthesia produced a definite elevation in maternal oxygen capacity and in the oxygenation of maternal venous blood; the fetal circulation showed a decidedly high oxygen level. Nitrous oxide, supposedly administered with at least 20 per cent oxygen, produced definite maternal and fetal anoxemia. With cyclopropane the maternal arterial and venous specimens contained elevated and almost equal amounts of oxygen. The blood of infants delivered from these mothers was not so well oxygenated as that of those born under ether, though more satisfactory than that of infants born under nitrous oxide oxygen. The general relationship of oxygen content to the presence or absence of apnea in all the infants studied was discussed in that paper and will be referred to later.

The combination of nitrous oxide oxygen with ether has been employed extensively at the Boston Lying-in Hospital as a comparatively safe anesthesia for both mother and baby. Asphyxia attributable to its use has not been clinically apparent, and theoretically it offers a margin of safety over nitrous oxide and oxygen alone. With the latter mixture induction is easy and rapid, but anesthesia can be carried only to a certain depth without increasing the nitrous oxide at the expense of the oxygen. If the proportion of the latter present is only 20 per cent, an actual and often marked anoxemia may result for mother and baby if the oxygen be further diminished. The effects of this have been well shown by Eastman (2). The addition of ether vapor should obviate this difficulty and permit relaxation and the other benefits of deeper anesthesia without jeopardizing the oxygen percentage. In this hospital the proportion of oxygen is never knowingly allowed to fall below 20 per cent; should deeper anesthesia be required, as is usually the case, a small but variable amount of ether vapor then suffices to produce this effect. The widespread use of this technique in this and other clinics, and the data secured for ether and for nitrous oxide and oxygen used separately aroused interest in the effect of their combined use. It was assumed that, could figures be obtained, they would show oxygen levels not so high as those for ether but above the anoxemia approached with nitrous oxide and oxygen.

On first attempts it seemed technically impossible to make reliable measurements of blood oxygen in the presence of the two anesthetics. Each interferes to a different degree with the standard Van Slyke-Neill technique for gas analysis, and for each a special modification of that technique has been devised. Thus the method of Shaw and Downing gives an accurate measurement of oxygen in the presence of ether, and that of Orcutt and Waters satisfactorily corrects for the presence of nitrous oxide. No success was obtained by attempts to combine both special methods for the particular problem under study. It was noted, however, that in samples containing either nitrous oxide or ether alone and analyzed by the standard Van Slyke-Neill technique a greater inaccuracy occurred in the presence of the former. Nitrous oxide in the blood gave results at

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TABLE I.—DELIVERIES UNDER NITROUS OXIDE OXYGEN AND ETHER

Delivery*	Maternal					Onset of respiration §	Fetal				
	Oxygen capacity	Arterial oxygen	Per cent	Venous oxygen	Per cent		Oxygen capacity	Arterial oxygen	Per cent	Venous oxygen	Per cent
1 N.D.	13.5	10.7	79.2	10.8	80.0	A	18.6	9.4	50.5	2.1	11.3
2 N.D.	17.4	14.6	83.9	11.9	68.4	A	22.3	6.6	29.6	4.4	19.7
3 N.D.	16.0	10.8	66.9	8.8	55.0	B	18.4	1.3	7.1	0.15	0.8
4 N.D.	15.9	12.1	76.0	15.2	75.5	B	16.6	6.12	36.2	0.94	5.6
5 Br.	15.4	13.3	86.5	11.5	74.5	C	27.5	12.2	44.3		
6 Ces.	15.5	13.0	83.8			A	22.1	3.7	13.4	0.10	0.36
Average of 6	15.6	12.4	79.5	**11.6	**70.7		20.9	6.9	30.2	**1.54	**7.55
7 N.D.	17.5			5.1	29.2	B	22.7	3.3	14.7	0.72	3.2
8 N.D.	19.2			17.0	88.5	A	21.3	6.1	28.6	2.8	13.2
9 L.F.	15.7			12.1	77.0	A	24.5	8.4	34.3	4.2	17.1
10 Ces.	15.5			11.7	75.5	A	26.5	2.6	9.8	0.24	0.9
11 N.D.	13.8			12.2	88.5	A	22.1	10.6	47.9		
Average of 11	15.9			‡11.6	‡71.2		22.4	6.4	28.8	†1.9	†9.02
12 N.D.						A	21.9	5.7	26.5	1.2	5.6
13 N.D.						A	19.8	12.4	62.6	4.4	22.2
14 L.F.						A	17.5	5.9	33.7	2.4	13.7
15 N.D.						A	19.9	5.5	27.6	1.7	8.6
16 N.D.						A	22.1	8.9	40.4	2.1	9.5
17 N.D.						B	22.7	4.9	21.6	1.9	8.7
18 Ces.						A	23.5	9.8	41.6	2.1	8.9
19 N.D.		•				B	21.5	6.8	31.8	0.02	0.09
20 N.D.						A	22.6	7.9	34.9	1.9	8.4
21 N.D.						A	26.3	10.4	39.6	6.9	25.8
22 N.D.						A	24.4	4.5	18.4	0.65	2.7
23 N.D.						A	26.9	10.7	39.9	1.4	5.2
24 L.F.						A	21.6	7.9	36.8	4.4	20.8
25 Ces.						A	20.6	10.4	50.5	2.0	9.7
26 Face presentation						B	25.6	3.9	15.2	1.04	4.1
27 L.F.						B	24.6	5.4	22.0	0.2	0.8
28 Ces.						A	22.5	4.9	21.8	4.7	20.8
Average of 28 fetal arterial; 26 fetal venous							22.4	7.03	31.5	2.16	9.55

*N.D.—Normal delivery; L.F.—low forceps; Br.—breech; Ces.—cesarean.
§A—Immediate; B—delayed; C—delayed and resuscitation required.
**Average of 5; †Average of 9; ‡Average of 10.

least 2 volumes per cent too high for the oxygen present; moreover, repeated determinations upon the same sample gave inconstant results. With ether, on the other hand, both the standard technique and the Orcutt and Waters modification showed regularly less than 1 volume per cent error, and this was always toward a falsely high oxygen level. Therefore, in blood containing the two disturbing substances, one had a choice between using a method which corrected for the large and inconstant error due to nitrous oxide, or a method which corrected for the small and constant error due to ether. Moreover, nitrous oxide, being the basal anesthesia, might be expected to be present in comparatively large quantities in the blood as the results proved; while ether, which was added

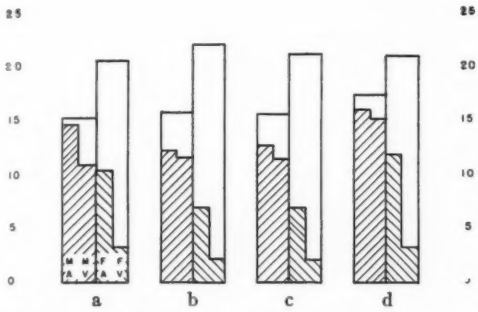

CHART 1. Maternal and fetal oxygen relationships. M. A., Maternal arterial blood; M. V., maternal venous blood; F. A., fetal arterial blood; F. V., fetal venous blood. The height of the column represents volumes per cent of oxygen capacity (plain) and of oxygen content (shaded). Diagram a is taken from data published by Eastman. a, no anesthesia; b, nitrous oxide oxygen and ether; c, nitrous oxide oxygen; d, ether.

irregularly and in small amounts would be a less distorting factor. Accordingly it was decided to make determinations by the method of Orcutt and Waters, correcting for nitrous oxide, and to admit a small error due to ether present. It must be remembered in considering the data that this error would result in figures for blood oxygen which were slightly above the true amount present. This error was probably maximal in the maternal arterial blood and minimal in the fetal venous blood, since ether must have been greatest in the one and least in the other.

The technique of securing blood samples from the maternal circulation and the umbilical vein and arteries at delivery was that described in the previous study. When 4 samples were obtained at a given delivery, exact synchronization was not always achieved; but the fetal blood in all instances was representative of that in the infant's circulation before or at the onset of respiration. The method of Adriani was used for storing samples over mercury in collecting syringes. Patients were anesthetized by the regular staff of the hospital and by the standard technique as here described. The majority of deliveries were normal as shown in Table I, which presents the data from the 28 infants studied.

It is obvious from the table that the results varied over a wide range. This is due to a number of uncontrolled factors, which include

TABLE II.—AVERAGE OXYGENATION OF BLOOD AT DELIVERY

Anesthetic	Maternal			Fetal		
	Oxygen capacity	Oxygen content		Oxygen capacity	Oxygen content	
		Arterial	Venous		Arterial	Venous
None*	15.4 vols. per cent	14.7	11.0	20.8 vols. per cent	10.5	3.3
Nitrous oxide oxygen and ether	15.9	12.4	11.6	22.4	7.0	2.2
Nitrous oxide and oxygen	15.7	12.8	11.5	21.5	7.0	2.1
Ether	17.6	16.2	15.3	21.3	12.0	3.3

*Data from Eastman (3).

anatomical differences, the element of time, the use of pre-anesthetic medications, and the individualization of anesthesia to a given patient at a given stage. The levels of the three substances supplied to the patient—oxygen, nitrous oxide, and ether—are not static, but must be varied constantly by the careful anesthetist to meet the demands of the moment. However, as already stated, the anesthetists always attempted to keep the oxygen supply at or above a minimum of 20 per cent of the anesthetic mixture.

The results are most easily appreciated if compared with data from deliveries without anesthesia and from those in which ether or nitrous oxide and oxygen alone were used. To simplify this comparison, averages are given in Table II and presented graphically in Chart 1. Those in diagram a for deliveries without anesthesia are taken from data published by Eastman (3) whose studies of fetal blood gases originally aroused our interest in the subject. It is obvious that even under normal circumstances the newborn infant has a low supply of oxygen. Diagram b, Chart 1, shows the results obtained in the present study, while c and d portray averages from our earlier studies of deliveries under nitrous oxide and oxygen and under ether. The effects of these have been described briefly at the beginning of this paper. The similarity between diagrams b and c is at once apparent, and indicates that the addition of ether did not modify the anoxemic effect of nitrous oxide oxygen anesthesia in these patients.

TABLE III.—AVERAGE VOLUMES PER CENT NITROUS OXIDE IN BLOOD AT BIRTH

Anesthesia	Maternal		Fetal	
	Arterial	Venous	Arterial	Venous
Nitrous oxide oxygen and ether	20.4	18.3	13.75	10.0
Nitrous oxide and oxygen	28.0	21.7	13.5	9.8

The method of Orcutt and Waters makes possible an accurate measurement of nitrous oxide itself in the blood analyzed. Average figures for the 2 series of deliveries, with and without added ether, are presented in Table III. As was expected, somewhat more of this substance appeared in the blood of women who received it as their sole anesthetizing agent. It is interesting to note, however, that nitrous oxide was present in the fetal circulation in similar amounts in both series. This might mean that above a certain maternal level increased amounts of nitrous oxide will not pass the placenta, or that the presence of ether influences placental permeability to this gas. In any event, the addition of ether certainly did not seem to lessen the amount of nitrous oxide reaching the fetus in the cases studied. It would be of interest to measure the amount of ether itself in the blood of these infants, and to compare it with the amount present in a series of infants delivered under drop ether anesthesia.

Whenever cord blood was secured for analysis, an attempt was made to describe the promptness of respiration in the infant. The designation, *A*, was used for infants breathing and crying strongly at once; those requiring some resuscitation by the obstetrician were graded as *C;* and the symbol, *B*, was used for infants whose behavior was between these 2 extremes. According to this classification the average oxygen levels are presented in Table IV together with similar figures for the 2 anesthetics used separately. Infants delivered under ether showed no correlation between onset of respiration and level of blood oxygen, a fact which presumably indicates the unmeasured narcotizing effect of ether upon the fetal respiratory center. On the other hand a direct relationship between anoxemia and apnea appeared in those born under nitrous oxide oxygen. The data for nitrous oxide oxygen ether also show such a correlation for the *A* and *B* babies. The one infant requiring resuscitation (*C*) had a very high level of oxygen in the umbilical vein (fetal arterial blood) rather than a low level as might have been anticipated. However, this was a breech delivery, the only one in the series, and the mechanical interruption of circulation through the cord for some moments before the birth of the entire infant may have contributed to this anomalous result. Until the head was born the cord was compressed between it and the birth canal. Immediately after the birth of the head, a fresh quantity of blood from the placenta must have filled the umbilical vein, and this composed the specimen obtained. The umbilical arteries in this particular cord were so collapsed that no specimen could be obtained from them, which is a condition usually accompanying fetal anoxemia.

TABLE IV.—RELATION OF APNEA TO OXYGENATION OF FETAL BLOOD

Type of anesthesia and onset of respiration	Average volumes per cent oxygen in blood	
	Arterial	Venous
Ether		
14 A	11.6	2.9
3 B	13.3	3.9
4 C	12.4	4.5
Nitrous oxide and oxygen		
19 A	7.3	3.2
2 B	4.0	0.85
Nitrous oxide oxygen and ether		
20 A	7.1	2.6
7 B	4.5	0.71
1 C	12.2	....

A, Immediate; B, slightly delayed; C, delayed.

Since it was planned to study unselected hospital deliveries, no attempt was made to prescribe a routine pre-anesthetic medication, and a number of different drugs and dosages were administered to the women studied. The most frequent analgesia consisted of 3 grains of seconal and 1 or 2 doses of 1/150 grain each of scopolamine. An attempt to tabulate the relationship of amount of medication with levels of blood oxygen showed no correlation. There was, however, a rough agreement be-

tween amount of medication and degree of apnea.

The belief that asphyxia neonatorum is constantly associated with profound anoxemia at birth is suggested by the work of Eastman (2) and of Wilson, Torrey, and Johnson. In their studies, measurements of fetal oxygen levels were made upon infants selected as presenting clinical evidence of severe asphyxia. In all instances, a definite anoxemia was found. However, the data presented in Table I, as in the earlier paper from this hospital, indicate that extremely small amounts of oxygen may be found occasionally in the blood of unselected infants presenting slight apnea or none at all. This suggests a surprising capacity of the infant to withstand marked anoxemia, although probably the time factor is of great importance. It is certainly unlikely that the infant can tolerate such situations for more than very brief periods, nor should this evidence be taken to suggest a wide margin of safety in the use of obstetrical anesthesia.

SUMMARY AND CONCLUSIONS

In 28 infants delivered under nitrous oxide, oxygen and ether anesthesia, the oxygen content of umbilical cord blood at the moment of birth was determined. Measurements were made upon samples from the umbilical vein (fetal arterial blood) in all infants and upon samples from the umbilical arteries (fetal venous blood) in all but 2. Simultaneous specimens were obtained from the maternal arm veins in 10 and from the maternal radial artery in 6 instances. Apparently the analyses were sufficiently accurate to be significant although the presence of ether may have resulted in values slightly above the actual oxygen level present, particularly in the maternal specimens.

As compared with results from deliveries under ether anesthesia alone, these mothers and infants showed a significantly diminished degree of oxygenation. The results were almost identical with those from a series of deliveries under nitrous oxide and oxygen alone.

The infants born under nitrous oxide oxygen and ether had as much nitrous oxide in their blood as did those born under nitrous oxide and oxygen alone, though this gas was present at a lower level in the maternal blood of the former group than of the latter.

Usually, although not always, fetal anoxemia was associated with apnea at birth. Occasionally infants born with such low oxygen levels as 2.6 volumes per cent in the arterial blood, breathed and cried actively at once. In such instances the anoxemia must be only of brief duration.

Judging by the amount of oxygen reaching the fetus at birth, the data presented indicate nitrous oxide and oxygen alone or combined with ether to be a less satisfactory obstetrical anesthesia than ether alone.

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ETIOLOGY AND TREATMENT OF ULCERS OF THE LEG

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THE history of surgery from its earliest beginnings has been marked by an endless succession of new methods for the cure of chronic ulcers. These remedies, enthusiastically presented, have enjoyed their brief hour of popularity and then have been forgotten together with their predecessors in favor of more recent innovations. With the accelerated rate of change that marks the modern world, the stream of new ulcer cures has become vastly augmented in recent years. Each year sees numerous new methods advanced with all the faith and hopefulness that attended the launching of the former methods. The bewildering gamut includes all the fads and fashions of modern medicine, including irradiation with roentgen-rays, infra-red and ultra-violet rays; vitamins and hormones, internally and locally; physical therapy, which includes alternate pressure and suction, intermittent venous stasis, and acetyl-choline iontophoresis; to say nothing of the infinite variety of lotions, ointments, and plasters, including, of late, those containing urea, allantoin, and extracts of maggots. A cursory review of the literature reveals no less than 50 different treatments advocated within the last 2 years for the treatment of leg ulcers. The truth of the old observation that multiplicity of remedies indicates a lack of any really effective one was never better illustrated than in the treatment of ulcers of the leg.

From the welter of changing fashions in the treatment of crural ulcers, one therapeutic fact survives. It has long been found that gentle, mechanical pressure is effective in promoting the healing of ulcerating and granulating surfaces. This time-honored principle finds application in the treatment of burns, in promoting the survival of skin grafts, as well as in the treatment of ulcers. Its efficacy has been attested to so often clinically and experimentally that there is no question as to its value. Douglas has shown by actual measurements that the healing rate of chronic ulcers treated by elastic compression is actually more rapid than the previously established ideal rate of healing for recent wounds. In our experience in the peripheral circulatory clinic of Northwestern University Medical School, mechanical measures have been the mainstay of our therapy for ulcers and eczemas of venous origin, and are relied upon almost to the exclusion of all other forms of treatment. We have come to believe that ulcers of the leg do not, as a rule, constitute a difficult problem, and our management of leg ulcers falls into a simple scheme.

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ETIOLOGY OF LEG ULCERS

The term, "leg ulcers," has been used instead of the conventional "varicose ulcers" because these lesions are not limited to limbs affected with varicose veins. In fact, the most extensive and refractory ulcers are often found as sequelæ to deep vein thrombophlebitis in patients who have minimal or no varicosities. As will be shown later, there is no essential difference in pathogenesis, clinical manifestations, or treatment between these and the true varicose ulcers. The term, "phlebitic" or "postphlebitic" ulcer, would more appropriately apply to both groups of lesions.

While specific, neoplastic, and traumatic ulcers do occur on the lower extremities, the vast majority of leg ulcers are related to disturbances of the venous circulation. The most familiar are the varicose ulcers and these will be discussed first. The pathogenesis of these lesions is usually ascribed to stasis and to chronic, passive congestion, resulting from impaired venous return due to the varicose veins. We have repeatedly pointed out (3, 4, 5) that this conception is not in accord with many of the facts observed in a study of varicose ulcers. Thus, it is frequently noted that

there is no parallel whatever between the severity of the varicosities and the incidence and degree of ulcer. Indeed, as has already been mentioned, the most extensive and least tractable ulcers frequently are associated with scarcely recognizable varicosities.

If static, the skin lesions of varicose veins should always be in the most dependent portions of the leg. This, of course, is not always the case. Nor would chronic congestion explain the topographical relationship which exists between the ulcers and the varices. Immediately beneath the cutaneous lesion, large varicose pools may be palpated, or their presence may be demonstrated by infra-red photography; and the long axis of the ulcer usually follows the course of the dilated vessel. It must be obvious that if any chronic, passive congestion occurs as a result of varicose veins, it will affect the tissues in contact with the capillary bed which ultimately drains into the varices and not those structures immediately superjacent to the trunks themselves. Furthermore, areas of induration and pre-ulceration are frequently separated by only a very few millimeters from skin that is perfectly normal in texture and color. It is difficult to reconcile this sharp limitation of the lesions with the wide overlapping of the superficial venous circulation which we know to exist. Finally, in conditions of known chronic, passive congestion such as accompanies long standing myocardial decompensation, ulcerations of the type here considered are not encountered.

Against the explanation of chronic passive congestion we have postulated an inflammatory genesis for the cutaneous complications of varicose veins. The complications represent a sequence of changes beginning with phlebitis and pass through the stages of periphlebitis and cutaneous induration to the eventual development of eczema or ulcer. Phlebitis is by far the most frequent complication of varicose veins, and most patients who have varicosities of any material degree for any considerable period of time experience inflammation sooner or later within segments of the dilated veins. The explanation appears obvious. Due to the stasis, anoxemia, back pressure, and degenerative changes of the intima within the varicose veins, these vessels constitute a site of predilection for circulating organisms. Bacteria reaching the blood stream from infected distant foci or in the course of intercurrent infections tend to localize in the varices. Frequently, latent infection is present and becomes activated from time to time by slight trauma, after operation, delivery, or general indisposition. The inflamed vein segment appears as a dull red, firm, slightly tender cord. Constitutional symptoms are mild or absent. The process appears, runs its subacute course, and subsides to reappear at intervals in the same or different segments of the varicose veins.

The second stage in the genesis of the cutaneous complications of varicose veins is the development of the so called periphlebitic indurations. The inflammatory process, which at first was localized to the vessel wall, ultimately extends to the adjacent skin and subcutaneous tissues. This results in a circumscribed area of low grade cellulitis. These round or oval patches appear in their active stages as dull red, indurated, warm, and slightly tender plaques. As the inflammation subsides, the vein which gave rise to it can often be palpated as a trough or channel coursing through the indurated perivenous tissues. The cycle of recurrence and subsidence is usually repeated; each episode leaves more and more permanent, irreversible changes in the skin and subcutaneous structures. These consist of pigmentation, induration, atrophy, cicatrization, and fixation to the subjacent tissues. The familiar woody, brown or mahogany color indurations are produced in which there is ischemia from scar tissue contraction with resulting impairment of resistance and reparative capacity. Slight abrasions or contusions to such areas give rise to ulcers which tend to spread and which may display little tendency toward healing. Secondary infection from without adds to the tissue damage and makes for further chronicity, thus completing the vicious circle.

Ulcers following deep vein phlebitis. The second great cause of crural ulcers is thrombophlebitis of the deep veins. The sequence of events in the evolution of this type of lesion is much more difficult to follow than in the

varicose ulcer, and several of the steps are as yet unexplained. Apparently the initial phenomenon in these cases is thrombophlebitis of the femoral or iliac veins. Such deep vein inflammations occur characteristically, as puerperal "phlegmasia alba dolens" or as complications following operations. In addition to general symptoms and local evidences of inflammation, edema of the extremity is a typical manifestation of impaired venous return. The edema disappears in the milder cases to recur for a short time when the patient begins to be up and about. In more severe involvements the edema may persist for months and it sometimes remains permanently.

Several types of complications may be engrafted upon the chronically edematous limb of the patient who has had deep vein phlebitis. In some, recurring attacks of an erysipelas-like infection of streptococcic origin sweep over the limb with attendant symptoms of acute toxemia and leave in their wake increasing amounts of subcutaneous fibrosis. In time, a true elephantiasis may develop. The skin of the involved extremity may become thickened, discolored, and leathery, and its surface may be roughened, fissured, and eczematous.

A more frequent type of late complication is the development of plaques of inflammation and induration in the skin and subcutaneous tissues which resemble those appearing about varicose veins. However, no large venous channels can be demonstrated coursing through these indurations. In the absence of any other convincing explanation as to the genesis of these indurated areas, we have assumed that they begin as phlebitides involving the smaller superficial veins.

Whether or not this explanation is the correct one is not certain; but once they are formed, the clinical course of these indurations is identical with that described for the lesions developing about varicose veins. They tend to be more extensive, however, to develop more rapidly, and occasion a greater crippling of the tissues than is usually seen following varicose vein infections. Ulcers develop on the basis of these indurations, just as they do on those described earlier, except that they are more extensive and disabling and less amenable to treatment than are the ordinary varicose ulcers. When, indeed, ulcerations occur that are out of all proportion to underlying varicosities, it can be assumed almost always that they are the sequelæ of deep vein inflammations.

Thus, the vast majority of leg ulcers are associated with diseases of the veins. Whether due to varicose veins or to deep thrombophlebitis, they are essentially infectious in origin and develop on the basis of periphlebitic infiltration and cicatrization. They are similar in pathogenesis and clinical manifestations and respond to similar forms of therapy. The essential, predisposing pathological change is ischemia from inflammatory sclerosis of the skin and subcutaneous tissues. Secondary infection from without adds to the fibrosis and circulatory insufficiency. Although disease of the veins constitutes the initial step in the genesis of these lesions, the tissue changes are permanent and irreversible, and the ulcers may persist or continue to evolve even after complete eradication of the associated varicosities.

TREATMENT OF CRURAL ULCERS

As was stated before, our management of leg ulcers falls into a simple scheme in which the use of mechanical pressure is the mainstay. It must be emphasized that the treatment is almost invariably ambulant; bed rest and elevation are rarely found necessary. The patients are, for the most part, working people, and they are permitted to go about their usual affairs without restriction so long as the pressure bandages are in place. Indeed, we have succeeded not infrequently in healing ulcers by ambulant treatment after prolonged bed rest had failed. Recumbent management is limited to the small group of cases to be described later, which do not tolerate occlusive dressings of any type and to those with acute infection severe enough to demand bed rest.

For obtaining gentle, elastic pressure, we have come to rely almost exclusively upon Unna's paste boot, not only for the treatment of ulcers but also for other complications of varicose veins, including local phlebitis,

phlebitic indurations, and varicose eczemas. We recognize that the same principle of elastic pressure may be achieved by other measures, such as elastic adhesive bandages, elastic bandages with rubber sponge dressings, and various types of paste-impregnated bandages. We have used some of these preparations with considerable satisfaction but, since we have had wider experience with the Unna boot than with all other forms of pressure bandage, we shall limit our discussion to this measure alone.

The Unna paste boot has proved so regularly effective in our experience in the treatment of leg ulcers that it is difficult for us to understand its very limited use in general medical practice. We have often made the statement, and advisedly, that no other therapeutic measure at our command, other than an injection of morphine, so regularly yields the desired results as does Unna's paste boot. The unbearable pain rapidly subsides, the edema disappears, the exudate diminishes in amount, and the indolent, necrotic, unhealthy ulcer base is quickly converted into healthy, firm, red, granulation tissue. The vast majority of ulcers progress uninterruptedly to complete healing without recourse to further therapeutic agents.

Occasionally, in long standing, callous ulcers, after the usual initial rapid improvement, the tempo slows, and eventually a stage may be reached in which no progress can be seen from one change of boot to the next. Under these circumstances, renewed stimulus may be obtained by strapping the ulcer with strips of adhesive tape and by applying the boot over the strapping. This time honored, simple expedient is surprisingly effective both in the production of granulations and the hastening of epithelization. If in time this stimulus also wears off before the ulcer is entirely healed, further acceleration may be secured by applying pads of rubber sponge under the boots. These are of particular value in deep, punched-out ulcers, in that they apply elastic pressure to the floor of the defects.

Technique. Unna's paste may be purchased commercially, or, if large quantities are used, can perhaps be prepared more economically by the pharmacist or nursing staff. The technique of preparation is not difficult. Our method is as follows:

Zinc oxide, 1 part
Gelatine, 2 parts
Glycerine, 3 parts
Water, 4 parts

Heat glycerine until steaming and then add gelatin slowly and stir it in. Then add water and stir as it is being added. Heat mixture to boiling. Pour over zinc oxide powder in jar and stir until cool. Cut into 6 ounce lumps and wrap in waxed paper.

When the boot is applied, the quantity needed is melted in a water bath. The paste should be fluid enough for smooth application with a brush and not too hot for safety or comfort to the skin. A layer of paste is painted on the surface of the ulcer as well as that of the normal integument, and extended from the base of the toes to the knee. If the ulcer involves the submalleolar region, it is frequently advisable to include the heel in the boot. A layer of gauze bandage of sufficient thickness to give body to the boot is then wrapped about the limb. Great care must be taken to avoid twists or creases in the bandage, since pressure or constriction to the indurated areas may be sufficient to produce a new ulcer. To obviate this danger, students in the clinic are taught to cut each successive turn of bandage, and so insure a perfectly smooth wrapping. Over this bandage another layer of paste is painted and then covered with a second thickness of bandage. Adhesive strips are applied in spiral fashion to keep the bandage from slipping.

As a rule the boots are changed once a week at first. Later, when edema has subsided and the amount of exudate has diminished, they may be left on for 2 or 3 weeks or longer. If the drainage is exceptionally profuse, they may require changing twice weekly. It is important to caution against having the boots removed at home, since recrudescence of swelling militates against prompt healing. Patients are instructed to return with boots on. They are removed in the clinic and the limbs are bathed with soap and water, dried, and the new boot is applied. When healing is complete, further protection with Unna's paste or elastic bandages for several weeks longer is advised until the scar is sufficiently

firm and tough. Postthrombophlebitic limbs with persisting edema may require permanent supportive bandaging to prevent swelling and tendency to ulcerate further.

TREATMENT OF ASSOCIATED VARICOSE VEINS

Eradication of concomitant varicosities is, of course, an integral part of the management of patients with varicose ulcers. It is our opinion, however, that the significance of obliteration of varicosities for the healing of ulcers is greatly exaggerated. The literature contains many reports of prompt healing of chronic, intractable ulcers, following the injection of varicose veins. Leriche has recently removed several cases from the category of "varicose ulcers" because the ulcers recurred in spite of complete extirpation of the varicosities.

From what has been said regarding the pathogenesis of ulcers which are associated with varicose veins, it is perfectly obvious that once the tissue changes which lead to ulceration have become established, they will persist irrespective of what is done to the varicose veins. Treatment of the ulcer resolves itself into the healing of an ischemic lesion in a zone of inflammatory sclerosis. The rationale of treatment of associated varicosities is largely the prophylaxis against further inflammation with subsequent increasing fibrosis, by interrupting the cycle of pathological changes. When the varices are eliminated, recurrence of phlebitis and consequent increase in the crippling of the surrounding skin is largely prevented. Nevertheless, if the tissues have become sufficiently devitalized, recurrences of the ulcers may continue to develop even after all varices have been removed.

Because ulcers are always infected with a multiplicity of organisms, and because they are often acutely inflamed when first seen, we usually defer active attack upon the veins for several weeks. Unna's boot therapy is carried out as described until the inflammation has subsided and healing is in progress. Obliteration of the varicosities is then very cautiously undertaken. It is begun with a minimal degree of irritation to avoid a flare-up of the phlebitis.

Our management of the varicose veins consists of ligation and injection, comparable in all essentials to that reported by other writers in the field. The almost universal unanimity of opinion as to the treatment of varicose veins speaks eloquently for the efficacy of modern management. We do preliminary ligation in all cases with material degrees of tension within the varicosities, and in which reflux is demonstrable by the Trendelenburg test, from the saphenofemoral junction downward. We advocate high ligation and division of the long saphenous vein with retrograde injection of sclerosing fluid into the distal vein segment. This is followed by ambulant injections until all varices are obliterated. Our choice of sclerosing solution has run the gamut, and we are now using soaps of the fatty acids—sodium morrhuate, potassium oleate, or sodium ricinoleate—as the most satisfactory of any that have as yet been tried.

OTHER THERAPEUTIC MEASURES

As has been stated, most ulcers of the leg respond promptly to the simple scheme of management outlined and do not constitute difficult problems. In exceptional cases difficulties may arise which require adjuvant measures. No mention is made of ointments, and indeed, ointments play a very small rôle in our management of ulcer patients. If the exudate is particularly profuse and if it becomes excessively malodorous from saprophytic infection, a mild and bland antiseptic ointment applied to the surface of the ulcer and incorporated in the Unna boot will inhibit the growth of these organisms and greatly reduce the odor. For this purpose, we usually use a 2 per cent mercurochrome ointment in equal parts of lanolin and vaseline, or some similar, simple preparation. Likewise, a bland protective ointment is occasionally applied to inflamed and irritated skin adjacent to an ulcer, although, as a rule, Unna's paste is painted directly on the surface in static dermatoses and eczemas. During the initial stages, which may be acutely painful, ointments containing local anesthetic preparations such as nupercaine, benzocaine, or butyn often give prompt relief. If there is

co-existing ring worm infection, painting with gentian violet or a similar antiseptic application is indicated.

An interesting and sometimes perplexing problem is presented by the patient who is apparently sensitive to the exudate from his own lesion. In this type of so called "eczematid" reaction, no type of occlusive dressing is tolerated, and retention of the exudate may give rise to local or general disturbances. Locally, the exudate is apparently caustic and provokes progressive scalding and irritation of the skin with attendant severe itching and burning. Severe, systemic, allergic reactions are seen occasionally. One patient with very moderate ulceration of both legs became violently ill following the application of Unna's paste boots, with nausea, vomiting, hematuria, fever, edema of the face and hands, and generalized pruritic cutaneous eruption. The most severe changes were in the areas covered by the boots. The skin of both legs was completely covered with massive hemorrhagic blebs. To rule out sensitivity to the materials in the paste, patch tests were done with the various constituents of the paste and with the paste itself with totally negative results.

Such general reactions on an eczematid basis are rare, but local intolerance to the exudate is relatively common. When this intolerance is present, aggravation of the dermatitis follows any type of occlusive dressing. In such instances we customarily use moist compresses of aluminum subacetate until the eczema is healed and the exudation has ceased. This frequently entails recumbent treatment and constitutes one of the few exceptions to ambulant management of patients with ulcers and eczemas of lower extremities.

Coincident general disease may be an important factor in delaying the healing of ulcers and must, therefore, be recognized and adequately treated. Syphilis, of course, must be ruled out by serological as well as clinical tests, and, if present, must be appropriately combatted in addition to the local management of the ulcer. In such cases mercury ointment may be applied directly to the ulcer and incorporated within the paste boot. Similarly, diabetes, anemia, malnutrition, vitamin deficiency, and specific infections must receive due consideration.

Of all the general conditions militating against the healing of ulcers, perhaps the most important is arteriosclerosis with peripheral arterial ischemia. As has been emphasized, the essential lesion in chronic ulcer is cicatricial ischemia. The more extensive the fibrosis surrounding an ulcer, the poorer the circulation and the slower the healing. If there is general peripheral circulatory insufficiency superimposed upon the local ischemia, healing becomes increasingly more difficult or even impossible. Concomitant diabetes may further add to the problem. We have had to admit defeat in a small number of cases falling into this group, and have even had recourse to thigh amputation because of disabling, intractable, bone-involving ulcers that resisted all other forms of treatment. In general, when excessive degrees of arterial insufficiency are present, because of local or general causes, or both, the usual expedients for increasing local arterial circulation must be added to the simple supportive measures required for the ordinary case. These will include suction-pressure treatment, intermittent venous stasis, and iontophoresis with acetylcholine derivatives.

Skin grafts. On the basis of our conception of the pathogenesis of leg ulcers, skin grafting should find an important place in the management of these lesions. If the condition is due not to chronic passive congestion, which would affect all of the tissues of the extremity and jeopardize the "taking" of the graft, but to local inflammatory changes of the skin and subcutaneous tissues with normal circulation in the adjacent structures, excision of the pathologically altered tissues and replacement with full thickness grafts would be a logical solution to the problem. We have no doubt that this is really the case. Such management, however, would necessitate bed rest and hospitalization for a number of weeks, both for preparing the field for operation and for healing of the grafts. Because of our almost universally satisfactory results with the purely ambulant management of ulcer cases, we have had very little recourse to operative methods.

Skin grafts on ambulant patients, whether by the Thiersch or pinch graft method, are usually disappointing. The exudate is usually profuse enough to float the graft from the surface and the transplant fails to take. We have had some success with pinch grafts buried in the granulations of slow, chronic ulcers, but, in general, skin grafting has not played an important part in our management of leg ulcers.

SUMMARY

Most ulcers of the leg are associated with disturbances of the venous circulation. The two principal underlying conditions are varicose veins and deep vein thrombophlebitis. The cutaneous lesions are usually ascribed to chronic passive congestion occasioned by the vein disease.

This explanation cannot be reconciled with the many facts which are revealed in a clinical study of these conditions. They seem, rather, to be inflammatory in origin, and a sequence of events may be traced from initial phlebitis, through the stages of induration and cicatrization to the eventual ulcers. Both groups of ulcers, therefore, are phlebitic in origin and the essential tissue change in both is inflammation with subsequent fibrosis and cicatricial ischemia.

Of the innumerable remedies offered for ulcers of the leg, gentle mechanical pressure has proved most effectual, and, in our clinic, provides the mainstay of our therapeutic regimen. Eradication of concomitant varicosities and attention to associated local and general conditions are also included. While skin grafts are theoretically a logical solution, we rarely have recourse to them because of the satisfactory results obtained by purely ambulant methods.

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THE PRODUCTION OF EXPERIMENTAL ACUTE APPENDICITIS (WITH RUPTURE) IN HIGHER APES BY LUMINAL OBSTRUCTION

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OBSERVATIONS made on the vermiform process of man and the cecal appendage of the rabbit indicate that this segment of the intestinal canal secretes fluid. In a large number of common domestic and laboratory animals, no evidence of secretion of fluid was obtained when the cecal appendage was obstructed. Obstruction of the vermiform appendix of man and of the cecal appendage of the rabbit resulted in the production of a histological picture very similar to that of spontaneous appendicitis in man.

These considerations suggested that it would be interesting to study the secretory capacity of the vermiform appendix in anthropoids—the only family, other than the human, in which a true vermiform process occurs. For the purposes of this study three chimpanzees (Anthropopithecus troglodytes) and two howling golden gibbons (Hylobates entelloides) were available.

TECHNIQUE

Anesthesia. The animals were anesthetized primarily with ether: a copy of the anesthesia box described by Elder from Fulton's Laboratory (7)[1] was used. As soon as possible, sufficient sodium amytal was given intraperitoneally to provide surgical anesthesia (usually about 35 milligrams per kilogram of body weight).

Surgery. With strict aseptic technique, a right rectus incision was made, and the cecum and appendix were delivered. After the tip had been amputated for control section, and after cultures had been made from the lumen, a cannula of glass was inserted and tied with No. 30 commercial linen. Physiological tests were made on the appendix and the base was tied with linen, and the region was walled off from the rest of the abdominal cavity by silk sutures attaching the cecum to the anterior abdominal wall in a circle about the base of the appendix. Further physiological tests were made, including the determination of the volume-elasticity, or the luminal capacity of the appendix at certain pressures from zero to 100 centimeters of water. The wound was closed with the appendix and mesoappendix coming out through it, dressed outside the skin in vaseline gauze.

Recording. The cannula was connected to a recording mercury manometer of such proportions that 0.55 cubic centimeters of fluid had to be forced into the cannula from the appendix to raise the pressure reading from 0 to 100 centimeters of water. It was with this that we determined the volume-elasticity, using a one cubic centimeter tuberculin syringe connected to the closed appendix-manometer system by a T-tube and making volume corrections for the manometer. The pressure recording was started at atmospheric pressure.

Care of the animal during recording. Preliminary tests with dogs had shown that with prolonged anesthesia under amytal, the required dosage is about one-sixth of the initial dose per hour for the first half-day, thereafter gradually diminishing. An electrically driven syringe was usually used to force this dosage continuously into the subcutaneous tissues of the thigh. Preliminary experiments with dogs had shown also that change of position every few hours is necessary to prevent the development of pneumonia, if anesthesia is to be maintained over a prolonged period, and, for

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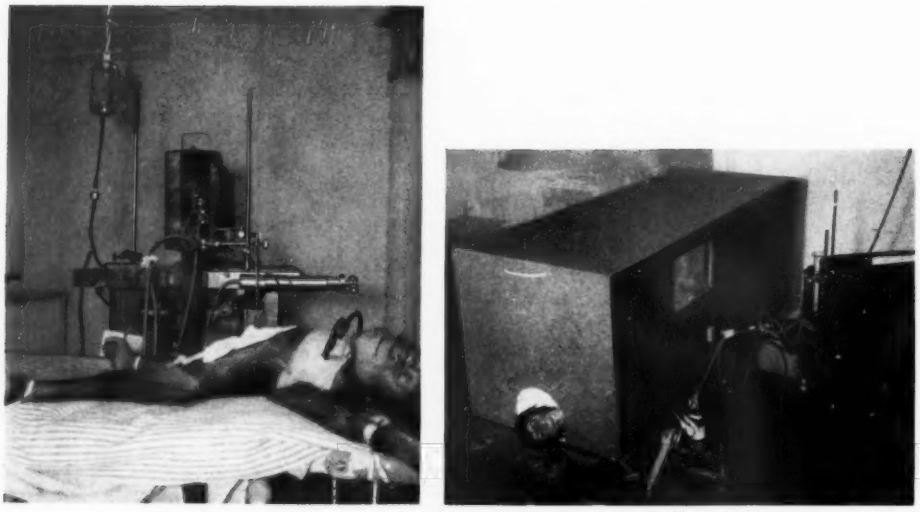
[1]The authors wish here to express their thanks to Dr. John Fulton of the Yale University School of Medicine for his many valuable suggestions concerning the handling of these apes.



a b

Fig. 1. a, General arrangement of animal and apparatus for recording pressure changes. The tube from the elevated intravenous flask is doubly clamped during the recording of the spontaneous rise of intraluminal pressure. b, Another view showing the general arrangement of the apparatus for the recording of spontaneous pressure rise within the chimpanzee appendix. The thermostatically controlled temperature box has been placed over the animal.

this reason, the position of the apes was changed every 4 hours. The studies on dogs had shown also that the prevention of pneumonia required the maintenance of normal body temperature, and that, at this time of year (November and December) maintenance of a constant environmental temperature of 29 degrees C. resulted in an almost constant body temperature of 37.5 to 38 degrees C. under continuous amytal anesthesia. A thermostatically controlled temperature box was therefore constructed to fit over the operating table.

During the recording, temperature, respirations, pulse, depth of anesthesia, volume of urine, and specific gravity of urine, were recorded. We administered subcutaneous fluids as dictated by the urinary findings, using alternately 0.9 per cent sodium chloride and 5 per cent glucose solutions. The general arrangement of the apparatus which we used is indicated in Figure 1.

FINDINGS

Three chimpanzees and two gibbons were used in this study, the chimpanzees being 10 to 12 months of age, and having a sitting height of 15 to 20 inches and the gibbons being 4 to 7 years old and about the same size.[1] Four animals were in excellent health, but one chimpanzee (No. 2) proved at operation to have an extensive tuberculosis both of the mediastinum and bowel, which contributed to his death prior to the completion of the planned procedures.

Chimpanzees. Anatomical and physiological observations. The anatomy of the appendical region agreed with the reports of Reider and of Kelly and Hurdon. The appendicocecal junction in each case was of Treves's type II, the length averaging 11 centimeters (extremes 7 and 15 centimeters) and the diameters averaging 5 millimeters. In each case, although the appendix was similar in form to the usually observed human type II organ, it was impossible to straighten it out completely because of the inadequacy of the mesentery. It was noteworthy from the point of view of the purposes of our experiments

[1]The authors wish to express their gratitude to Mr. Fred M. Truax, commissioner of parks, playgrounds, and public buildings of the city of St. Paul for his generous proffer of the facilities of the Como Park Zoo, and for the invaluable assistance of his staff in the care and handling of our animals.

TABLE I.—VOLUME ELASTICITIES

Chimpanzee 1		Chimpanzee 2		Chimpanzee 3	
Pressure cm. water	Volume c.cm.	Pressure	Volume	Pressure	Volume
0	0	0	0	0	0
20	0	20	0	20	0.01
40	0	40	0	40	0.01
60	0.07	60	0.28	60	0.01
80	....	80	0.50	80	0.11
100	0.15	100	0.70	100	0.13

(Limit of accuracy: approx. 0.01 c.cm.)

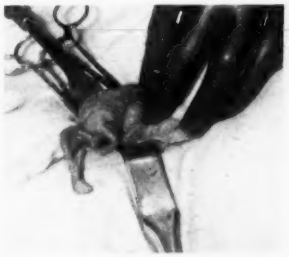


Fig. 2. Photograph of the cecum and appendix of a chimpanzee taken immediately after delivery from the wound.

that in each case the large blood vessels in the mesentery lay near the free edge, in no case near the appendix itself. Figure 2 shows the appendix of chimpanzee 3.

Cultures of the lumina of these organs showed almost every organism one could expect to find within the main lumen of the intestinal tract. The organisms reported included the following: Aerogenes, Bacillus welchii, Gram-positive spore formers, Escherichia coli communis, pleomorphic Gram-positive rods, streptococci, Gram-positive diphtheroids, and staphylococci.

Microscopic sections of the amputated tips of these appendixes were essentially normal. One section showed polymorphonuclear neutrophils just under the mucosal epithelium, in the epithelium, and also nearby in the lumen, calling to mind the observations of Isaacs and Danielian and of Jassinowsky and his co-workers concerning the passage of aged white blood cells through the intestinal epithelium as a normal mode of final disposition of these cells. (Figs. 3a and 3b.)

Following the placing of the cannula and prior to the ligation of the appendical base, the resistance which the appendix offered to the flow of fluid through it into the cecum (to which we have applied the term "absolute resistance to outflow") was determined, by means of the manometer already mentioned and a source of fluid more than a meter above the appendix, the rate of flow being adjusted with the aid of a screw clamp and a gravity drip bulb. Because of the variety of tests undertaken, not all could be performed on any one animal. In the second chimpanzee the appendix sustained a column of fluid 53 centimeters high, in the third 35 centimeters high, thus averaging very slightly higher than the normal human average of 38 centimeters previously reported (13). In animal 2, when the rate of flow was adjusted to 30 drops per minute, the resistance to outflow was 80 centimeters of water. In animal 3, the resistance at 10 drops per minute was about 42 centimeters of water, with peaks coming every 15 to 30 seconds and rising as high as 50 to 70 centimeters of water, findings identical to those in normal man. Stimulation of the appendical wall was performed in these same animals, by means of Faradic stimulation coming from a Harvard inductorium with the secondary coil at 7 centimeters and the primary supplied by two dry cells in series, a stimulus just sufficient to be felt with the finger. Stimulation of the wall caused a strong ring of contraction which raised the pressure required to keep a constant flow (Fig. 5).

The volume-elasticity in the first and third animals was 15 and 13 hundredths of one cubic centimeter at 100 centimeters pressure, respectively, and in the second it was 70 hundredths. The volume elasticities are given in Table I.

The presence of muscular tonus was demonstrated not only in the rhythmic variations in resistance to outflow already mentioned, but also in chimpanzee 1 by the fact that when the pressure was reduced to zero without withdrawing all the fluid, the pressure then rose in a few seconds to 5 to 6 centimeters of water, where it remained. When about 0.07 cubic centimeters was run into this organ and the syringe tube was clamped, there shortly appeared rhythmic variations in pressure between 55 and 62

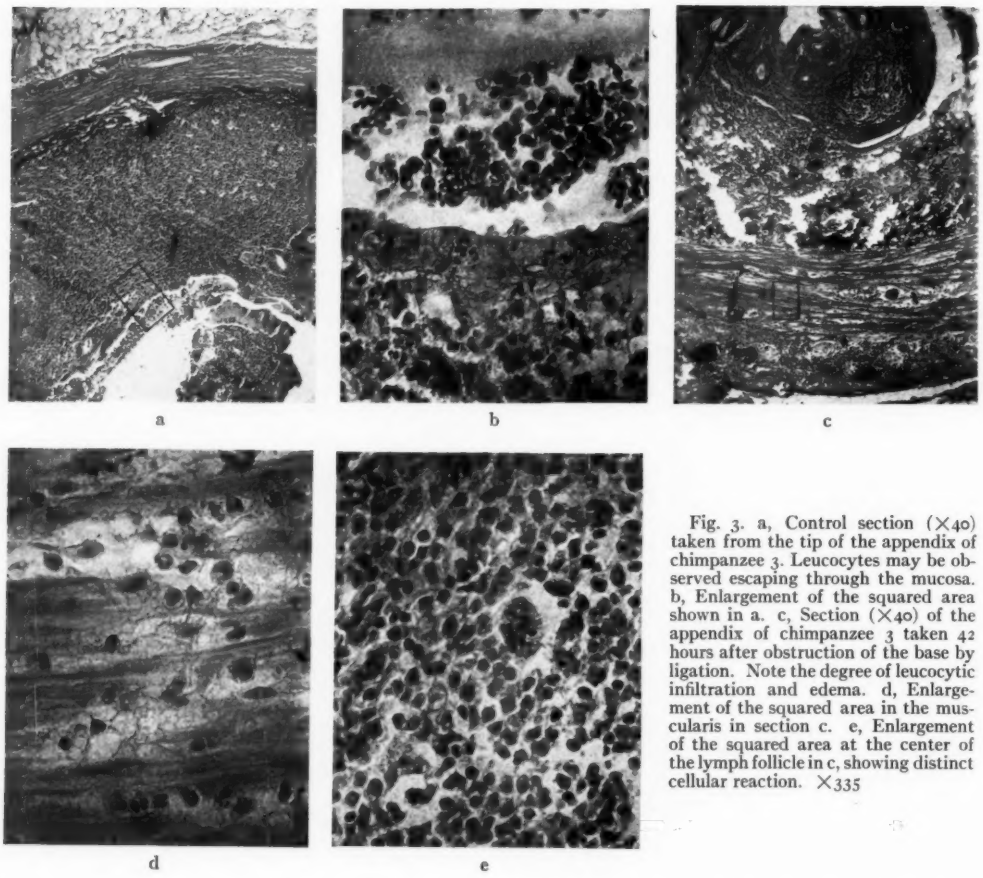


Fig. 3. a, Control section (×40) taken from the tip of the appendix of chimpanzee 3. Leucocytes may be observed escaping through the mucosa. b, Enlargement of the squared area shown in a. c, Section (×40) of the appendix of chimpanzee 3 taken 42 hours after obstruction of the base by ligation. Note the degree of leucocytic infiltration and edema. d, Enlargement of the squared area in the muscularis in section c. e, Enlargement of the squared area at the center of the lymph follicle in c, showing distinct cellular reaction. ×335

centimeters of water pressure, coming every 20 to 30 seconds, indicating rhythmic muscular activity.

Measurement of intraluminal pressure changes after obstruction of the appendical base in the chimpanzee. In all 3 experiments, when the appendix-manometer was made a closed system, a rise in pressure occurred. The amount of this rise in pressure and the time relationships are indicated in the charts in Figure 4. In chimpanzee 1 the pressure rose to 76 centimeters of water in 30 hours and 40 minutes, at which time rupture occurred. In the second animal the experiment was terminated by accidental death indirectly due to pulmonary tuberculosis at 10 hours; at this time the pressure had already reached a height of 42 centimeters. In the third, the pressure rose to 106 centimeters in 39 hours and remained there 3 hours, when rupture occurred. In the surviving animals appendectomy was done without opening the peritoneum, and both recovered.

In chimpanzee 1 a final volume elasticity determination was done at the conclusion of the pressure recording (Table II). At 80 centimeters leakage was first observed along the mesenteric border, both in the area which had been beneath the skin and in that which had been outside. It is evident a stretching of the appendical wall took place during recording when intraluminal pressure was rising.

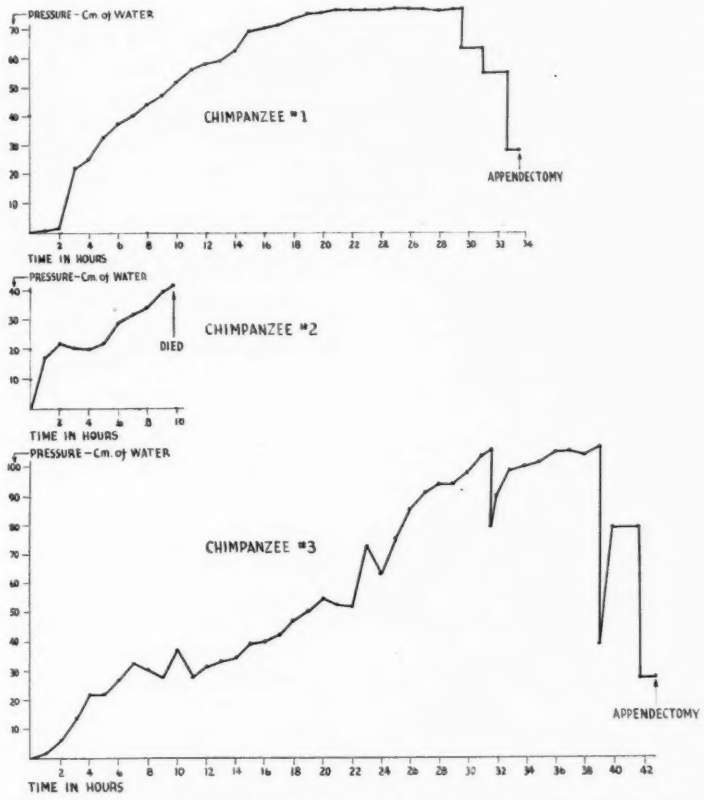


Fig. 4. Charts transposed from the kymographic records indicating the time relationship of the pressure rises within the lumina of the three obstructed chimpanzee appendixes.

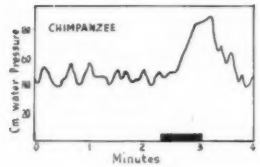
Microscopic changes resulting from spontaneous rises in pressure after ligation of the base of the chimpanzee appendix. Microscopic examination of the appendixes of all 3 animals showed diffuse appendicitis. In animal 1 sections were also taken from beneath the skin to avoid as much as possible the serosal reaction observed in the distal portion. This proximal section showed polymorphonuclear infiltration of all the layers, predominantly the mucosal and muscular layers, with lesser involvement also of the serosal layer. In the third animal examination showed rupture, edema, necrosis, and polymorphonuclear leucocytic infiltration of all the layers, primarily in the mucosa and muscularis, with pus in the lumen, and distally, disappearance of portions of the mucosa. The serosal reaction was considerable distally, but minimal in the portion of the appendix which had been beneath the skin (see Figs. 3c, 3d, and 3e).

Gibbons. Anatomical and physiological observations. In both gibbons the cecum and

TABLE II.—FINAL VOLUME ELASTICITY

CHIMPANZEE 1

Pressure cm. water	Volume of appendix c.cm.
0	0
10	0.40
20	0.60
30	0.80
40	1.00
60	1.15
80	Leakage



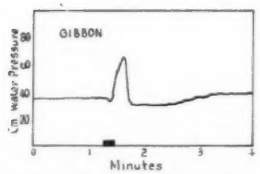


Fig. 5. Tracing of kymographic record showing, above, the curve of rhythmic variations in pressure required to keep a constant slow flow passing through the appendix into the cecum. At the point indicated by the heavy horizontal bar, Faradic stimulation was applied through a previously placed electrode to the wall of the appendix. The lower figure shows the absence of rhythmic variations in the gibbon, but a response to stimulation.

appendix lay free in the peritoneal cavity and were readily delivered. In both cases the appendix was of Treves's type I, or infantile form, and the three tæniæ continued from the cecum down onto the appendix for about half its length. The first appendix was 12 centimeters long and 8 to 10 millimeters in outside diameter, the second was 7½ centimeters long and of uniform 6 millimeter diameter throughout except for the bulbous end which was over 8 millimeters in diameter. The wall was found to be much thinner than that of the average human, and the internal diameter therefore larger. Cultures from the lumina showed the same multiplicity of organisms found in the chimpanzees.

The absolute resistance to outflow was determined in one animal and was 31 centimeters of water. When a flow of fluid at 40 drops per minute passed, the pressure required was about 39 centimeters of water, and there were no waves in the curve, a point in contrast both to the chimpanzee and man; upon Faradic stimulation, however, a rapid response was obtained as shown in Figure 5.

The volume elasticity was determined partially in each animal, and the values are shown in Table III.

The determination was not carried to higher levels in gibbon 2 because the organ was beginning to look extremely distended.

Measurement of intraluminal pressure changes after obstruction of the appendical base in the gibbon. The pressure recording lasted for 48½ hours in one animal and 22 in the other; the course of the changes is shown in Figure 6. In the first animal the pressure was artificially reduced to zero at 16 hours because it was feared the elevation present until that time might be due to fluid left after the initial physiological tests, which proved to be true, for the level did not rise again. In neither case was there elevation above the intraperitoneal pressure of 6 to 7 centimeters of water except in the first few hours.

Microscopic examination after the recording experiments. Microscopic examinations were made of the tip at the start and of the midportion at the end of each experiment. The final sections differed from the initial ones only in mild serositis (from handling). The configuration was in many respects similar to that of the human appendix, but the wall was thinner, with the muscularis 150 micra thick and the mucosal and lymphoid layer about 900 micra thick (Fig. 7).

EVALUATION

It has been shown that the appendixes of the 3 chimpanzees studied resembled that of man in many respects: grossly, microscopi-

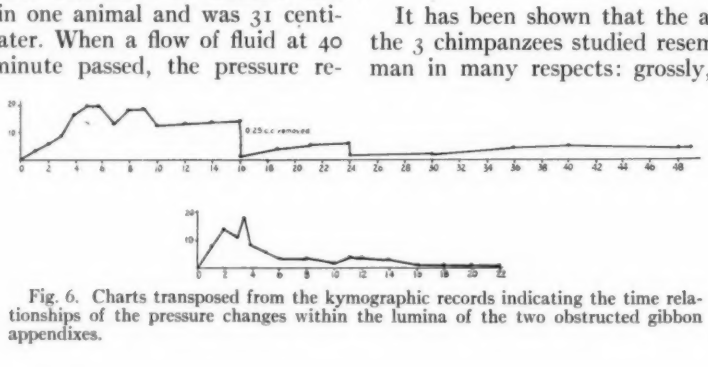


Fig. 6. Charts transposed from the kymographic records indicating the time relationships of the pressure changes within the lumina of the two obstructed gibbon appendixes.

TABLE III.—VOLUME-ELASTICITY

Gibbon 1		Gibbon 2	
Pressure cm. water	Volume c.cm.	Pressure	Volume
0	0	0	0
20	...	20	0.01
40	...	30	0.79
60	...		
80	2.1		

cally, as regards the luminal volume with various pressures (13), in reference to rhythmic contractions (1, 13), and in ability to form strong contraction rings upon Faradic stimulation locally (1). In chimpanzee 3 the absence of waves in the resistance to outflow with no fluid flowing (absolute resistance to outflow), the demonstration of strong contractile ability in the general wall of the appendix by Faradic stimulation, and the rhythmic variations in pressure required to keep a constant flow through the appendix into the cecum are all facts strongly suggesting that in this animal the situation is as found in man, in whom there is no apparent anatomically functioning sphincter mechanism at the base of the appendix, the resistance to flow being produced by all segments of the organ alike (1, 13). Finally it has been shown that the appendixes of 3 chimpanzees secreted fluid enough in excess over any possible absorption to build a pressure within the obstructed lumen, with development of acute inflammation of the wall, as has been shown elsewhere to occur in man (14).

In the gibbons studied, on the other hand, the resemblance of the appendixes to that of man was less marked. They were of the infantile type I of Treves, and had a much larger luminal volume at the same pressures than either the human or chimpanzee appendix. One lacked rhythmic variations in resistance to flow of fluid through it, though it presented an absolute resistance to outflow not greatly different from the 2 others, and contracted quickly on Faradic stimulation. Finally, and this is the essential difference from the point of view of the present study, both failed to secrete fluid sufficiently to elevate the pressure when obstructed, and the gibbons consequently did not develop appendicitis following obstruction. These 2 experiments therefore serve as excellent controls for the chimpanzee experiments and show

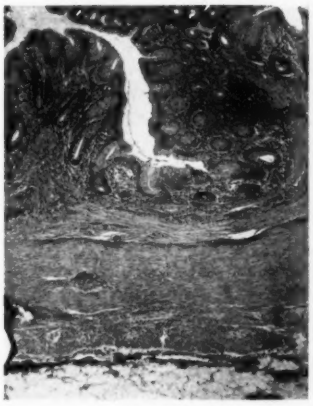


Fig. 7. Section of the appendix of gibbon 2 after 22 hours of recording in which no significant rise in pressure occurred. Note the essentially normal microscopic picture, save for serosal reaction. ×40

that the elevation of pressure was the essential factor in inciting the acute response there. It would, of course, be very interesting to obstruct the base of the gibbon's vermiform appendix and return it to the peritoneal cavity to note whether delayed rupture might occur. We hope sometime to do this.[1]

The purpose of these experiments was fulfilled in that, in contrast to what one may do in man, the process here was allowed to progress. Rupture occurred in the acutely inflamed appendixes of both the chimpanzees which survived long enough.

Acute appendicitis has been shown to be capable of production in milder forms by obstruction of the lumen in man, and in more severe forms by the same mechanism in the chimpanzee, in which the experimenter may let the process progress to gangrene and perforation. Therefore, it is logical to conclude that the severe advanced forms would also result in man if the process were allowed to continue for long intervals after obstruction of the base.

CONCLUSIONS

1. Anatomically and physiologically, the vermiform appendix of the chimpanzee has

[1]We have been fortunate in receiving several chimpanzee specimens from Dr. George Barnett, of Chicago, and from Dr. J. F. Fulton, of New Haven. Recently Dr. C. R. Schroeder, of San Diego, sent us the vermiform appendix and cecum of an orang-outang. It falls into Treves' type 1 classification. We have yet had no opportunity to determine the secretory capacity of obstructed appendix of gorilla or orang-outang.

been shown to be very similar to the human appendix.

2. Acute gangrenous appendicitis with perforation was produced in the chimpanzee by obstruction of the lumen, simultaneous pressure recordings showing the level of the intraluminal pressure to rise as high as 106 centimeters of water.

3. Anatomically and physiologically, the vermiform appendix of the gibbon bears less resemblance to that of man than is the case with the chimpanzee.

4. Pressure rises of significant magnitude did not occur after obstruction of the gibbon appendix, and consequently acute appendicitis did not attend luminal obstruction.

5. Since it has been reported that milder grades of acute appendicitis can be produced in man by obstruction of the lumen at the base, it is concluded that in man also obstruction of the lumen, if maintained a sufficient number of hours, would result in acute gangrenous appendicitis with rupture.

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CLINICAL SURGERY

FROM THE JAMES BUCHANAN BRADY UROLOGICAL INSTITUTE

RADICAL CURE OF HYDROCELE BY EXCISION OF SEROUS LAYER OF SAC

HUGH H. YOUNG, M.D., F.A.C.S., Baltimore, Maryland

THE treatment of hydrocele has been the subject of numerous reports in the literature in recent years; the tendency has been to avoid radically curative operations. This has gone, *pari passu*, with attempts to cure inguinal hernia by injection treatment, and even great prostatic hypertrophy by transurethral operations. The simple procedure of tapping has been used from time immemorial but requires frequent repetition, and in employing it one is always confronted with the hazard of infection. Recently I have seen one such case in which a large hydrocele had been tapped six times and, on the seventh, a fulminating infection resulted not only of sac but of subcutaneous tissues. Patient narrowly escaped serious consequences.

Aspiration, followed by the injection of some strong irritant to put an end to the reaccumulation of fluid, has been tried for years, and numerous substances have been used for the injection. In many cases in which this procedure was "successful," dense adhesions formed between the tunica vaginalis and the tunica albuginea covering the epididymis and testicle, occasionally leading to contractures that were painful. On other occasions small lobulated accumulations of fluid recurred between the epididymis and the testicle and tunica vaginalis, resulting in areas of marked tenderness and sometimes considerable pain. In some cases fine string-like adhesions were present between the epididymis and testicle, which as the fluid recurred, produced points of tension between the testicle and epididymis that were painful in character. The multiplicity of substances which have been proposed from year to year for the injection treatment of hydrocele are evidence of the unsatisfactory results.

The open operation has been the method preferred by surgeons in the majority of cases, whereas non-surgical practitioners have been prone to employ aspiration or injection. Statistics are at hand to show that excision of the sac is the most radically curative method, but the great vascularity of the thick walls of the sac, especially after sudden emptying of its contents and resulting engorgement of the vessels, has made the operation difficult. To avoid this, Winkelman advised only partial excision of the sac and inversion of the remaining portion, the edges of which were approximated posterior to the epididymis. Andrews' bottle operation, which consisted merely of opening the sac and turning it inside out and suturing behind the epididymis is a simple procedure, but leaves a large mass of tissue back of the testicle. It also has the disadvantage of being more frequently followed by recurrence than the operation of excision. The necessity of meticulous clamping and ligature of all bleeding points, and the proneness to occasional extravasations amounting at times to huge blood clots in the scrotum, have militated against the popularity of the excision operation, and are considerably responsible for the numerous attempts to devise curative methods by simple aspiration. As mentioned, although numerous substances have been tried, recurrence after the aspiration-injection treatment is far too high, and occasionally results in painful conditions.

For many years I have been an advocate of the open operation and have employed excision of the sac with its several coats. Great care was taken to ligate all bleeding points. The difficulty of accomplishing this, and the occurrence of a large hematoma caused me to use the bottle operation for a number of years, but I rarely was satisfied with the results.

A NEW SIMPLIFIED RADICAL OPERATION FOR HYDROCELE

Several years ago, in a case of hydrocele, I discovered, after incising the skin, subcutaneous tissue, and the dartos of the scrotum and after

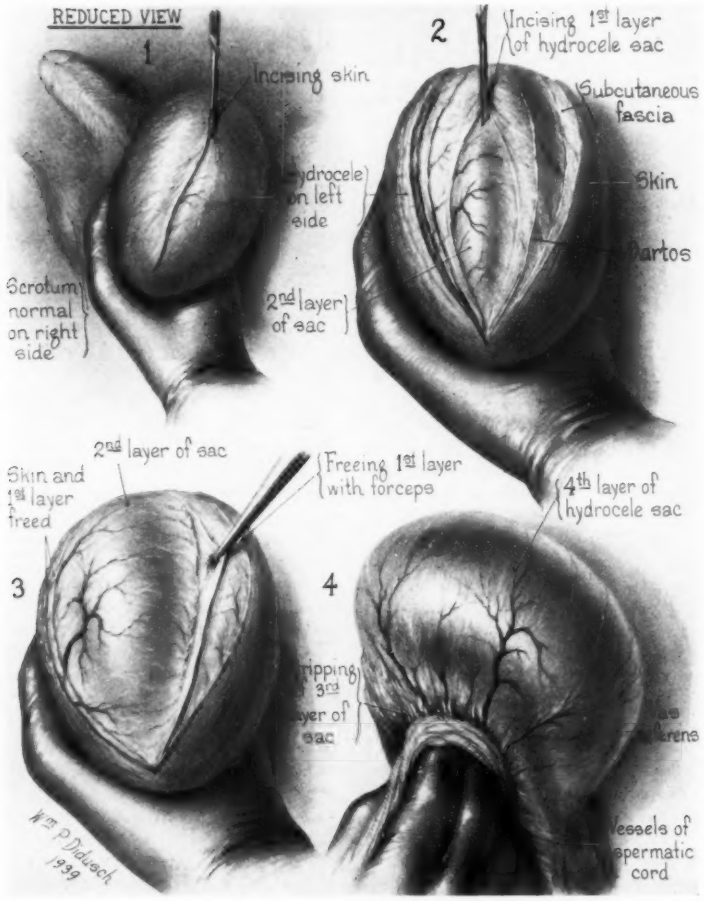

Fig. 1. Author's operation for hydrocelectomy (vaginalectomy). 1, Incision through skin from upper to lower end of hydrocele; 2, five-thirteenths natural size—skin, subcutaneous fascia, and dartos having been incised, the scalpel is incising the first layer of the hydrocele sac, which is then stripped back, 3; this second layer is similarly incised, and the third, which is then stripped back to the pedicle, thus exposing the fourth layer, 4. These layers are of extreme thinness, but can be easily divided and stripped from each other. (BUI 26837.)

delivering the hydrocele sac, that by delicately incising the outer coat at full length, layer after layer could be peeled back until finally only the serosa remained. The advantage of this technique was that, as the various layers were divided and stripped back, they carried with them most of the blood vessels of the sac, and when finally the serosa alone remained, there was very little left for ligation when excised. The problem of hemostasis was thus greatly simplified.

The accompanying drawings by Mr. Didusch made at the time of operation in one of my cases (BUI 26837), a patient operated upon a year ago, so graphically depict the various steps of the operation that little descriptive text is necessary. The case was one of a very large hydrocele of the left side of the scrotum. As shown in Figure 1, 1 (reduced in size), the sac was grasped between the thumb and finger of the left hand and put on tension. An incision, beginning at the lower and

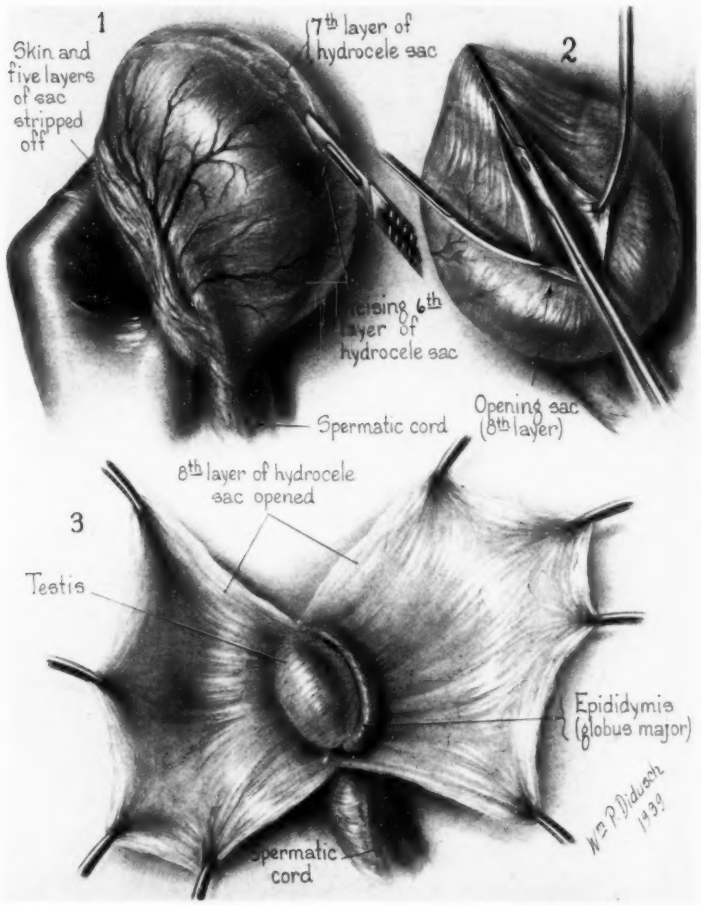

Fig. 2. 1, Showing condition present after five thin saccular layers have been stripped off together. This sixth layer is thicker than the other layers, contains many blood vessels, and corresponds to the subserous coat. It is easily divided, and stripped back, carrying with it the blood vessels and in some cases the vas deferens. Beneath it is a very thin layer, which may be delicately divided and stripped off from the last layer, which is the serosa or tunica vaginalis itself, 2. This is opened widely with scissors (2 and 3). (BUI 26837.)

extending to the upper end, was made through the skin, thus exposing the subcutaneous fascia (Fig. 1, 2) which was similarly divided (Fig. 1, 2). Beneath this lay the dartos which was also divided from bottom to top (Fig. 1, 2) thus exposing the outer layer of the hydrocele sac. This was delicately divided, a very thin layer being thus incised and pushed back partly on each side. Four other extremely thin layers were similarly divided. Then the five layers were stripped back together, exposing the sixth layer, which was thick and contained numerous large blood vessels (Fig. 2, 1). This sixth layer was carefully divided, thus exposing the seventh layer, which was extremely thin, transparent, but which by great care was divided with the scalpel. The sixth and seventh layers were then carefully stripped back, only the extremely thin tunica vaginalis being left intact, with the hydrocele fluid within it. This was then punctured, the

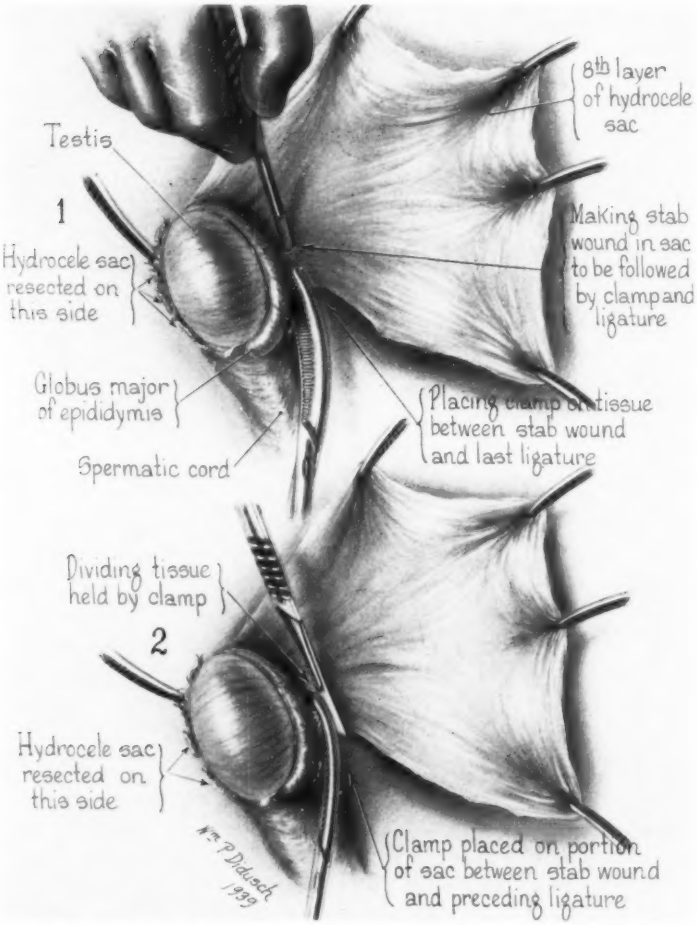
8th layer of hydrocele sac
Testis
1
Hydrocele sac resected on this side
Making stab wound in sac to be followed by clamp and ligature
Globus major of epididymis
Placing clamp on tissue between stab wound and last ligature
Spermatic cord
Dividing tissue held by clamp
2
Hydrocele sac resected on this side
Clamp placed on portion of sac between stab wound and preceding ligature
M. P. Didusch 1939

Fig. 3. 1 and 2, The thin serous layer is completely excised. (BUI 26837.)

fluid caught in a sterile flask for the manufacture of gonococcus media, and the sac then widely opened with scissors (Fig. 2, 2 and 3). Inspection showed a normal testicle and epididymis. No adhesions or pathological areas requiring dissection were present. The extremely thin serosa of the sac was excised by the technique depicted in Figure 3, 1. With a fine scalpel, a puncture was made, a Kelly clamp was inserted (Fig. 3, 1 and 2) and the sac was divided with a scalpel (Fig. 3, 2). The tissue held in these clamps was then ligated with plain catgut. These small ligated areas were left along the testicle on the inner side and the epididymis on the outer side (Fig. 3, 2). Care was taken to see that there were no bleeding points and that hemostasis was complete. Then the testicle, epididymis, and cord were replaced, the dartos was drawn together, and the edges approximated (Fig. 4, 3). Some subcutaneous tissue was included in this suture, as shown by the artist. A delicate gauze wick was inserted in the lower angle of the wound as a precaution. It was arranged to remove this on the following day. The skin was approximated with interrupted sutures of silk. The scrotum was enclosed within a gauze and adhesive bandage applied tightly so as to draw scrotum upward and obliterate operative space. Wound was dressed at end of a week

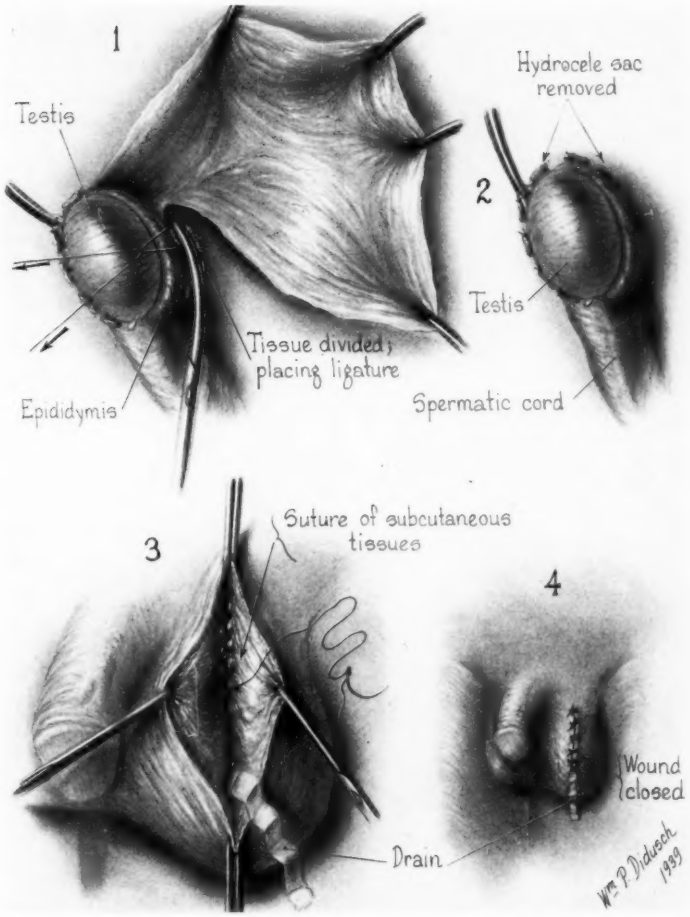

Fig. 4. The individual clamps are ligated with plain catgut close to the epididymis internally and testicle externally, 1 and 2, and the edges of the dartos are then picked up with forceps and approximated with continuous plain catgut. (BUI 26837.)

and the stitches removed. Patient advised to wear a suspensory for a time.

The operation, as described, has been done in a good many cases. In all it was possible to carry out the division of layers seriatim, until the thick subserous coat was encountered and divided. In some the next coat was so thin that it could not be separately divided, but was simply opened with the sac. No difficulty has been experienced in stripping back the outer layers from the tunica vaginalis and in leaving this extremely delicate membrane alone to be excised.

EXCERPTS FROM CLINICAL NOTES

CASE 1. The patient complained of pain in the scrotum. A small hydrocele was present and several pronounced bands of adhesions running from the tunica to the outer portion of the testicle. Fluid in the sac evidently caused these bands of adhesions to pull upon the testicle and epididymis and was undoubtedly responsible for the pain. In this case the tunica vaginalis was enucleated from within the other layers of the sac and excised. (BUI 24574.)

CASE 2. The testicle was smooth and everywhere normal, except at the upper and outer ends, where it was adherent to the epididymis by a broad line of adhesions, between which there was a cavity which contained fluid. These adhesions were divided. The patient had been tapped twice with recurrence. (BUI 26837.)

CASE 3. The vas and veins ran in the hydrocele immediately outside the subserous fibrous coat. There was a small fibrous band which ran from the hydrocele sac to the epididymis. This was divided. (BUI 26837.)

CASE 4. After 7 layers were peeled back the tunica vaginalis was opened. Examination showed marked adhesions between the tunica vaginalis and lower half of the testicle. The testicle was dissected free, thus leaving the lower half without serosa. On the left side, although the hydrocele was small, the sac was adherent to the testicle in several places with loculated areas of fluid in between. One of these passed beneath the epididymis, producing marked pressure and distortion. (BUI 26842.)

CASE 5. When the incision was made to divide the subserosa, the operator unintentionally allowed the point of the knife to touch the sac, which was immediately penetrated and fluid escaped. Had care been taken to cut only with the broad side of the knife, this would have been avoided. (BUI 27042.)

CASE 6. No difficulty was experienced in enucleating the serosa from within the subserosa, which was stripped back with gauze. When the outer coats had been stripped off, and the tunica vaginalis opened, it was found bound down to the tunica albuginea by very dense adhesions which required blunt and sharp dissection before the testicle could be freed. This case was characterized by considerable pain before operation. The patient had been tapped three times. (BUI 27103.)

CASE 7. An assistant in describing my operation in this case says, "The various fascial layers were opened and peeled back. The hydrocele was delivered and dissection of the various thin layers of the sac carried out by blunt and partial dissection. There was very little bleeding which was easily controlled by clamps. Finally the sac was transparent, and revealed a beautiful specimen apparently only a few cell layers in thickness. The sac was opened, the margins trimmed away closely, the testicle replaced, and the dartos approximated with continuous plain catgut." (BUI 27163.)

RÉSUMÉ

Non-operative treatment of hydrocele is often very unsatisfactory. Simple aspiration is followed by early recurrence of the fluid and sometimes infection.

The injection treatment often fails to cure the hydrocele and frequently results in painful adhesions.

Complete excision of the sac has encountered the objection that many blood vessels, requiring ligation, may be found, and are sometimes accompanied by postoperative extravasation. The bottle operation of inverting the sac, which was introduced to avoid these operative difficulties, is not infrequently unsuccessful and leaves a large mass back of the testicle and epididymis.

A new operation has been devised by the author and provides for incising the sac layer by layer and stripping the layers back until thin serous membrane is reached; this alone is excised. In this way hemostasis is easily secured, as very few vessels remain to be ligated. The operation is thus made more accurate, less destructive and hemorrhagic, and is radically curative.

FROM THE R. CLINICA CHIRURGICA, POLICLINICO

ALESSANDRI'S MODIFICATION OF LAMINECTOMY

Professor ROBERTO ALESSANDRI, Rome, Italy

THE modification that I have applied for more than 20 years to the usual procedure of laminectomy seems to me to simplify the difficulties of technique and notably to diminish trauma from operation. In addition to these advantages, the ligamentous osteo-aponeurotic system is preserved, thereby strengthening the vertebral column and protecting the spinal cord, which, after laminectomy with other methods, remains separated from the skin by soft parts only. This is especially important in vast and repeated resections of the laminæ for tumors of the cord.

This method is applicable to all those operations in which there results exposure of the laminæ. I have personally used it not only in operations upon the spinal cord and spinal roots but also in those of the Albee type.

No special preparation of the patient is required, nor are special instruments necessary. An ordinary scalpel and a curved or straight periosteum detacher are quite sufficient.

With the patient in the prone position, a slightly curved incision is made in the median line, convex toward the assistant. The skin and subcutaneous tissue having been cut, the spinous apophyses are exposed with the strong aponeurosis inserting on them. These insertions are cut near the spinous apophyses on one side only and precisely on the side opposite the operator. If two or three laminæ are to be resected, the incision should include at least two spinous apophyses above and two below the ones concerned. Then with a scalpel (see Fig. 1) and a periosteum detacher, the muscular masses which are located in the paravertebral lodge are detached from the lateral side of the apophyses and from the corresponding half lamina. A large and deep divaricator will displace the muscular masses, thus disclosing the side of the apophysis, its base and half of the lamina of one side. Then, with the scalpel directed toward the base of the spinous apophysis, the laminæ are severed from above downward successively one after the other (Fig. 2) for the required number. Sponge with hot tampons.

In such a manner the continuity of the spinous apophyses with their interspinous and supraspinous ligaments is preserved.

A few years ago Donati proposed the use of a bayonet-shaped scalpel, because by using such an instrument it is possible to sever the base of the spinous apophyses on a parallel and not on an oblique plane, as happens when a straight scalpel is used. This instrument may be useful but not necessary because my assistants, other surgeons, and I have always successfully used the straight scalpel.

With the scalpel and the periosteum detacher, the muscular masses are disinserted from the other half of the laminæ and a strong retractor (Fig. 3) will hold apart the spinous apophyses continuous with the interspinous ligaments, with the aponeurotic insertions of this side and with the muscular insertions on the spinous apophyses. At the bottom of the incision the laminæ are exposed

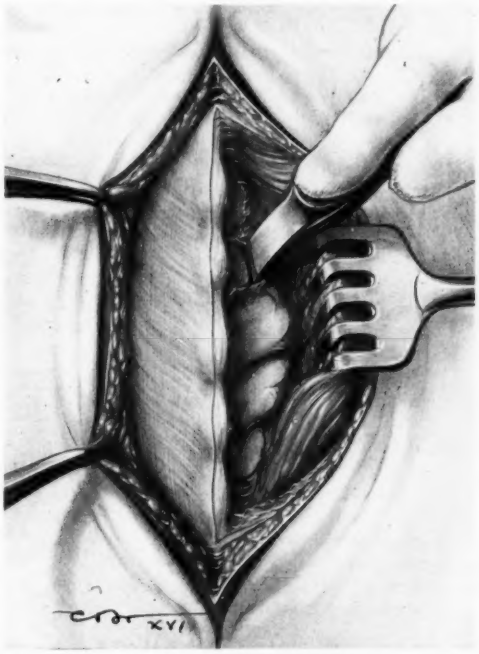

Fig. 1. Detachment of muscular masses in paravertebra space by means of scalpel and periosteum detacher.

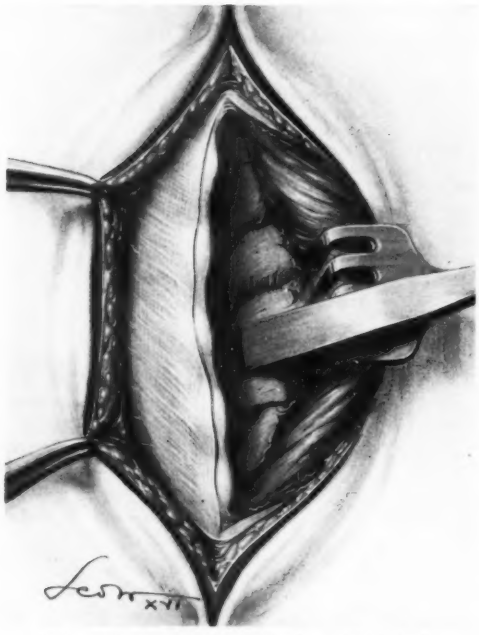

Fig. 2. Method of severing laminæ with scalpel.

and one can proceed according to indications, in general resection of the laminæ is necessary to get to the spinal cord.

When this part of the operation is completed and the divaricators have been removed, the muscular masses return toward the median line with the spinous apophyses attached to the muscles of one side, and by suturing between the apophyses the whole posterior ligamentous-muscular vertebral system is reconstructed. A few superficial stitches are passed on the aponeurosis. Generally no drainage is necessary.

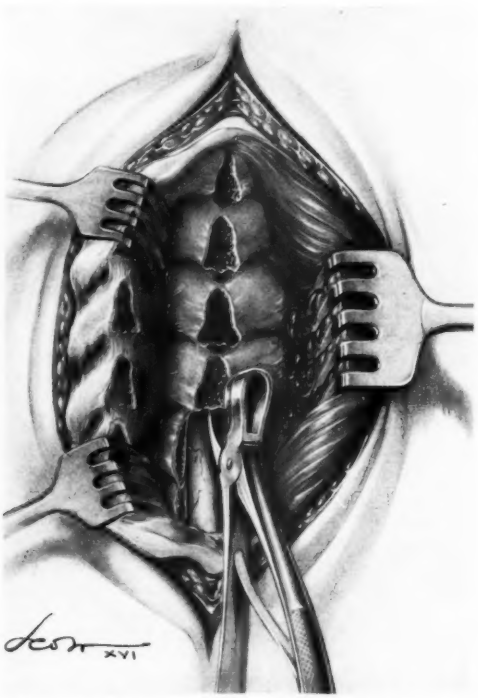

Fig. 3. A strong retractor holds apart the spinous apophyses, with the aponeurotic insertions of this side, and with the muscular insertions on the spinous apophyses.

I believe that this technique reduces the time of operation, that the loss of blood is diminished and, what is more important, bony protection of the spinal cord remains after the removal of the laminæ. This is very important if many laminæ are resected, as sometimes happens in the removal of tumors.

DOUBLE ELONGATIONS OF PARTIALLY CLEFT PALATES AND ELONGATIONS OF PALATES WITH COMPLETE CLEFTS

JAMES BARRETT BROWN, M.D., F.A.C.S., St. Louis, Missouri

A METHOD of elongating partially cleft palates was described in 1936,[1] the principle of which is that practically the entire soft tissue of the palate is freed from the bone, the major palatine arteries are loosened but not cut, and the entire mass of tissue is immediately set back—as a direct flap with preservation of its arterial supply—so that the anterior part, from just behind the incisors, is anchored all the way back at the posterior border of the bone. A gain in length is thus obtained equal to about as much as the expanse of denuded bone, the object being to have the longest possible functioning palate, to assist in nasopharyngeal closure in speaking and eating.

Some of the original illustrations of the procedure in Figures 1 to 4 show the complete freeing of the tissues from the bone, the preservation of the arteries and the anchoring of the palate to a little bridge of nasal mucosa that has been left behind for this purpose. The closure of the cleft itself is done usually at the same operation—as a preliminary step—in children, but may be done as a separate operation. In adults two stages are advisable because of excessive bleeding. The sequence of the elongation and the closure does not have to follow a definite rule; therefore, a field is opened for older children and even adults, who have had clefts closed many years before, to have their palates elongated in an effort to obtain better speech.

Observations made or emphasized since the original publication may be summarized, as follows:

1. It is still thought that the direct flap, elevated and immediately set back, so that the least possible thickening will take place, is superior to the delayed flap method of elongation.

2. Preservation of the major palatine arteries (often called the posterior) is possible in nearly all patients, and freeing is effected by careful loosening of all tissue around the artery, gently stretching it from the foramen and, if necessary, carefully cutting it away from the palate flap. These methods have seemed better than trying to dislodge the artery from its bony canal by trying to remove the posterior wall of the canal.

The palate may be gotten so free by this dissection plus complete separation of the aponeurosis from the bone that it may be easily "set-back," practically against the posterior pharyngeal wall in most instances. This finding is in contradistinction to that of others who think that preservation of the arteries prevents elongation.

This may seem somewhat of an equivocal point but it makes possible closure and elongation in a single stage, and it may give a less scarred and more pliable palate. If the arteries are cut, then the delayed flap method of Dorrance may be resorted to for safety's sake. However, if they have been lost at a *previous* operation, then the delayed advantage has already been gained and the flap could probably be used without further delay.

3. This method of elongation, even though involving a very wide dissection does not seem to interfere with the levators in the sphincteric action that attempts to close the nasopharynx. Even as the patient is waking in the operating room, very marked sphincter action can be seen.

4. In any procedure in which the posterior pillars are cut low down in the pharynx and then sutured behind the uvula to lengthen the palate, a tight scar band may be left right in the region of the greatest action; and if there is any levator action present, this procedure should be omitted if possible. The same is true of the employment of flaps from the posterior pharyngeal wall attached to the palate. These flaps may nearly or completely occlude the nasopharynx and also may give a "drum-head" noise from vibration in breathing.

5. If there has been a slough of the soft palate from previous operations, then, added to the elongation, may be the freeing and suturing of any tissue available, plus the use of a posterior pharyngeal flap attached to the palate if desired. This results in all possible closure between the mouth and nose, and, as there is no levator action, amounts to a flesh obturator. This, of course, has a great advantage over a dental prosthesis or over an extra-oral flap.

6. Any type of pharyngoplasty, mainly that of Wardhill, in which there is a reefing forward of the

From the Department of Surgery, Washington University School of Medicine.

[1]Surg., Gynec. & Obst., 1936, 63: 768–771.

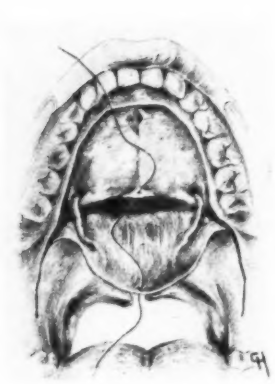

Fig. 1

Fig. 2

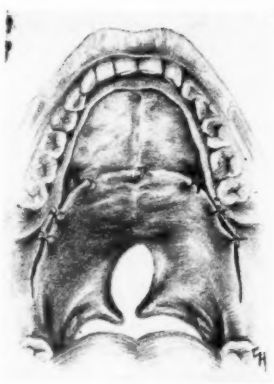

Fig. 3

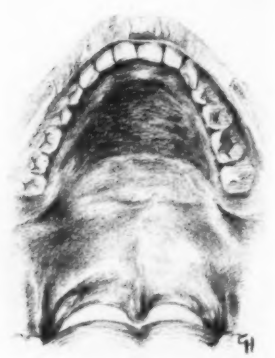

Fig. 4

Fig. 1. Palate detached from bone, but with both major palatine arteries intact. A little triangle of nasal mucosa has been left behind to which the palate is attached with the first suture. (All figures are diagrammatic.)

Fig. 2. Detail diagram of deep separation of the soft tissues around the artery; exposure and fracture of the hamulus and complete separation of the aponeurosis from the bone.

Fig. 3. Completion of the elongation. The palate has been set back and anchored as shown. Several layers of iodoform gauze soaked in balsam of Peru are placed smoothly and firmly over the exposed bone and may be removed in 5 to 7 days. The closure of the cleft may be done at this time, at a subsequent step, or may have been done at an earlier operation.

Fig. 4. Completed elongation and closure after healing has occurred, with about as much gain in length as the expanse of original bone in Figure 3.

superior constrictor may be added to this elongation procedure, but it has not proved as successful in my hands as in others'.

7. Tooth buds may be damaged as in any other flap elevating operation, if done too early; therefore, the elongation can be delayed until the second year or later if desired.

8. Results of the closure and elongation have been increasingly hopeful. The bone covers over in about 30 days; the palates usually smooth out, appear good and long, and, for these reasons, the contracture on the nasal surface in healing does not seem great enough to warrant trying to skin graft the raw surface.

Speech improvement has been almost dramatic in many instances, and the use of voice recording, either by simple direct methods, or electrical transcription has been of great help in permitting the patient to hear his own defects and thereby try to correct them. Speech training is important in all patients and the author is pleased to acknowledge invaluable help from Dr. M. A. Goldstein, Miss Mildred McGinnis, and other teachers of speech at the Central Institute for the Deaf and in the St. Louis public school system, and to Mr. C. E. Harrison of the Technisonic Laboratories, located in St. Louis, for his work with electrical transcriptions.

Most patients are also able to eat better than before the elongation.

9. Failures may be expected as more difficult palates are operated upon, that is, ones badly scarred and with tissue lost from previous attempts. Patients with as many as 18, 24, 45, and 55 operations to their credit in attempted repairs of lip and palate clefts have been seen.

10. Throughout the procedures of elongation there has been the fundamental aim that no

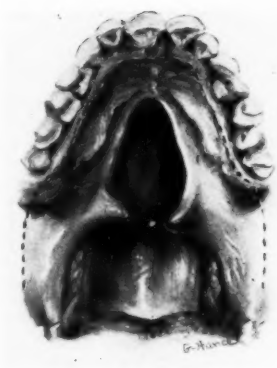

Fig. 5

Fig. 6

Fig. 7

Fig. 5. Diagram of a cleft with only a narrow band of bone and soft tissue, showing incision for first stage of a "double set-back."

Fig. 6. Healing resulting from the first stage set-back and with incision for the second stage of the "double set-back."

Fig. 7. Completed double set-back, accomplished by carefully splitting the remaining palate tissue in two from before backward and from side to side without breaking through into the nose—and literally setting the palate back on itself. The arteries usually have to be sacrificed in this double procedure. This gives a double gain in length without an opening into the nose anteriorly. The raw surface closes over in 2 to 4 weeks.

Fig. 8. Completed double set-back and closure of the cleft with about as much gain in length as the distance from the palate edge to the incisors and without any opening into the nose.

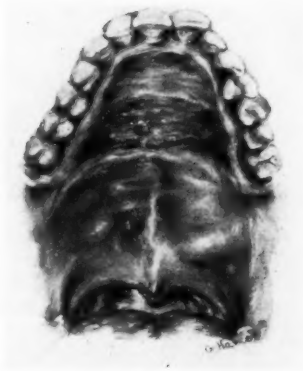

Fig. 8

opening should be left anteriorly, to avoid the use of an artificial dental obturator for closure of the mouth from the nose.

11. Acknowledgment is made to Dorrance for his pioneer work in calling attention to the advantage of the elongated palate and also for coining the term, "congenital insufficiency of the palate," for those instances of short palate with cleft palate speech but without an actual cleft.

12. Other methods of incision which leave a "V" of tissue over the bone, but necessitate more closure down the midline may have the immediate result of a smoother surface but give the added possibility of holes through the thin tissue that is sutured.

DOUBLE ELONGATIONS OF PARTIALLY CLEFT PALATES

In some partial clefts of the palates there is only a narrow ledge of bone just inside the alveolus with corresponding lack of mucoperiosteum with which a closure might be effected. In some of these the cleft may be so wide that even simple closure may be questionable.

Author's technique. In these patients it may be possible to do a double elongation of the palate, by first setting the available tissue back to the posterior border of the bone and then, after there is firm healing, further lengthening the palate by splitting the originally elongated part in two, from the edge of the bone backward, and from side to side. Care should be used not to open through the nasal mucosa, and the anterior free edge of the palate should be anchored entirely back on its own nasal mucosa (Figs. 5 to 8).

The closure of the cleft can be done at any one of the stages or as a separate procedure. The denuded nasal mucosa and fibrous tissue heals over as readily as the denuded bone does and, on late observation of the roof of the mouth, some trouble

Fig. 9

Fig. 10

Fig. 11

Fig. 9. A complete cleft of the palate that has been closed successfully in the usual lateral flap manner, showing incision for elevating the palate.

Fig. 10. Palate freed from the bone and from the nasal mucosa by carefully splitting the palate in two from side to side and from before backward and elevating it from the nasal mucosa without breaking through into the nose. About one-half of the thickness of the palate is left along with the nasal mucosa.

Fig. 11. An elongation or set-back of a complete cleft of the palate finished, with the anterior edge of the palate all the way back at the posterior bony edge and anchored to the nasal mucosa. No opening exists into the nose and the raw surface will cover in 2 to 4 weeks. It is possible that the arteries may have to be sacrificed in carrying out this dissection, but the flap does not have to be delayed, unless there has been an accidental opening into the nose.

may be had in even discerning that the areas are healed with "scar epithelium." The steps of the procedure are most easily followed in the illustrations and their legends (Figs. 5 to 8). The arteries will have to be sacrificed at the second stage, but it is apparently not necessary to revert to a delay in setting the flap back, unless a hole has been made through into the nose.

ELONGATIONS OF PALATES WITH COMPLETE CLEFTS

As a corollary to the finding that the nasal mucosa could be saved in double elongations and in palates with submucous bony clefts, it has been determined that elongations may be done in complete clefts of the palate that have been successfully closed at a preliminary operation. This elongation is also done to avoid an anterior opening into the nose and, therefore, to avoid the need of an artificial dental obturator.

Author's technique. The elongation is carried out as described for the partial clefts except that extreme care is taken to split the tissue in two from side to side and from before backward, leaving about one-half the thickness of the palate and, of course, the nasal mucosa behind. If even a small opening were made through into the nose, it would be best to replace the flap and elevate it later, with another attempt at not opening into the nose. The arteries may have to be sacrificed and, if there is any question of the blood supply, a delay in setting the palate back should be made. However, it is usually possible to go ahead with the elongation in a single stage (Figs. 9 to 11).

More difficulties in general can be expected in this procedure, and observations are limited for the present, but it makes possible a definite hope for improvement in speech in many patients who have had complete clefts simply closed many years before.

BONE GRAFTING

A New Technique

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ABOUT two and one-half years ago, after considerable experience in the use of the various mechanical apparatus devised as aids in the reduction and maintenance of reduction of fractures of the long bones, it occurred to the writer that certain of these gadgets might be of considerable help to the surgeon in certain bone grafting operations, particularly in the case of the long bones of the forearm and leg. The functions of the apparatus in bone grafting are to act as an almost perfect technical assistant to the operator in holding the limb while the site of non-union is exposed, to aid in manipulation of the fragments including their separation for freshening and shaping of the bone ends, to hold the properly fitted bone ends in approximation, and to assist in the complete immobilization of the fragments during the period of healing. The technique used by the writer is, in the beginning, almost identical to that used in the reduction of fractures. Kirschner wires, usually sixteen gauge, are passed through the upper and lower ends of the long bone, as illustrated in Figure 1a. In fractures near the lower end of the tibia, it is usually preferable to insert the lower wire through the os calcis rather than the lower end of the tibia (Figs. 3a and b). In choosing the apparatus to be used, the writer has found that any of the various long bone reduction apparatus in which the traction bows for suspending the limb will also grasp and tauten the wires are satisfactory. Such an apparatus is illustrated in Figure 1b. In one of the best and most widely used fracture reducing apparatus the traction bows are not made to grip the Kirschner wires. Separate wire tautnors are furnished with this machine, which, unfortunately, must usually be placed over the limb and in the operator's way. Such a machine is illustrated in Figures 2a and b. With this machine the technique described here could be used, should heavy pins not requiring tautening be used instead of Kirschner wires. However, we feel that there is very little excuse for using a heavy traumatizing pin in any case in which a small caliber Kirschner wire will function as well.

The technique described here is that routinely used in tibial grafts, as it is in cases of non-union of this bone that we have found the use of the apparatus described most valuable. It is our

Medical Corps, U. S. Army.

Fig. 1. a, left, Insertion of Kirschner wire drills through upper and lower end of tibia. (Illustration is from routine fracture case.) b, A type of apparatus ideal for use in bone grafting. (Illustration from routine fracture case.) *A*, Upper wire; *B*, extra wire through upper fragment for better fixation in cast; *C*, lower wire, more often inserted through os calcis, especially with fractures of lower third.

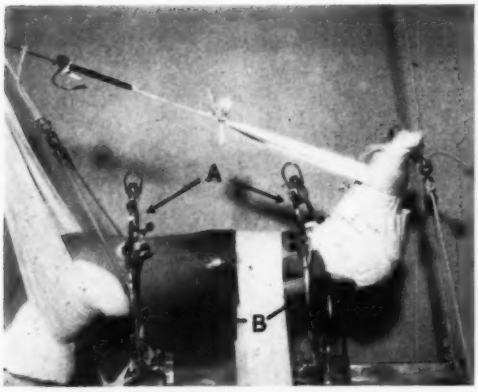


Fig. 2a

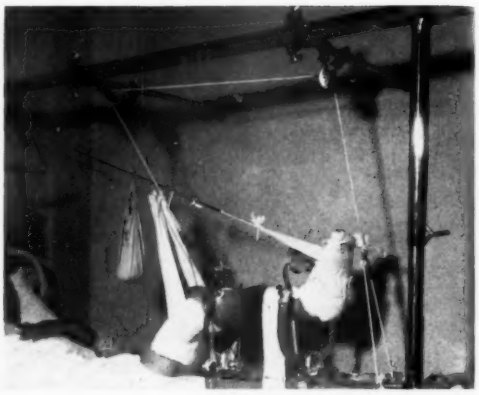


Fig. 2b

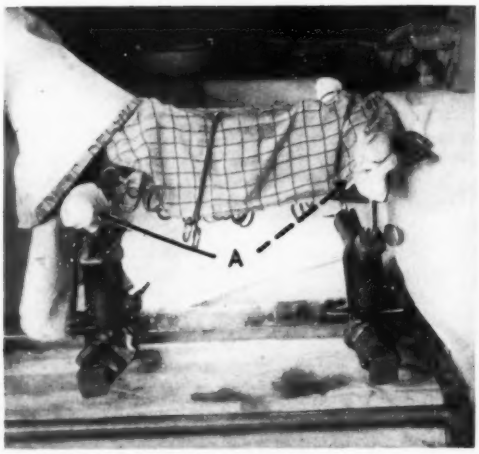


Fig. 3a

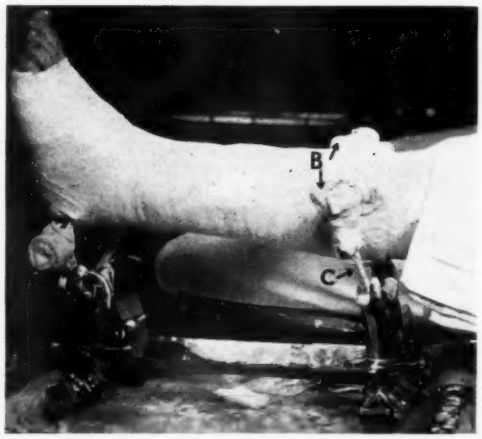


Fig. 3b

Fig. 2. a and b. An apparatus extremely popular for reduction of fractures, but not adapted to the technique described herein. *A*, Separate wire tautners required with this apparatus would be in the operator's way. *B*, The bows do not grasp and tauten wires as do those of apparatus in Figure 1 b.

Fig. 3. a, Leg suspended in apparatus and partially draped. Site of non-union has been exposed. *A*, Ends of Kirschner wires covered to prevent nicking of gloves or hands. b, Cast applied after completion of operation. Tension holders, *B*, have been applied to upper wires prior to removal of traction bow, *C*; not yet applied to lower wire. Limb removed from frame when plaster is hard enough, usually in 20 to 30 minutes.

Fig. 4. Case 1. W. A. H., aged 20 years. a, Roentgenogram shortly after injury through window in cast, compound fracture with loss of 2 inches of tibial bone substance and extensive destruction of soft tissue and circulatory damage. b and c, Lateral and anteroposterior views after 1 year, showing non-union of tibia with 2 inches of shortening. Weight bearing was possible the past 6 months in caliper splint.

Fig. 5. Case 1. a and b. Lateral and anteroposterior views in cast after repair by sliding inlay graft. Note the Kirschner wires, 2 through the upper and 1 through the lower end of the tibia to allow the use of the fracture reducing apparatus during operation and to immobilize the limb in a cast. The upper end of the graft, *A*, is fixed in the bed by a Kirschner wire, the point of which, *B*, penetrates the skin to allow easy removal later. The distal end of the graft is beveled and fitted in undermined graft bed and requires no other fixation. Cast unfortunately obscures detail.

Fig. 6. Case 1. Leg in cast following operation. Note the home made wire tautners applied to the upper and lower wires before the removal of the leg from the apparatus. Small aluminum commercial tension holders (Fig. 17) are much neater and do not obstruct the x-ray. A window is cut in the cast for the removal of the skin sutures. Immobilization of knee is not essential when the upper fragment is fixed by two wires.

Fig. 4a

Fig. 4b

Fig. 4c

Fig. 5a

Fig. 5b

Fig. 7a

Fig. 7b

Fig. 6

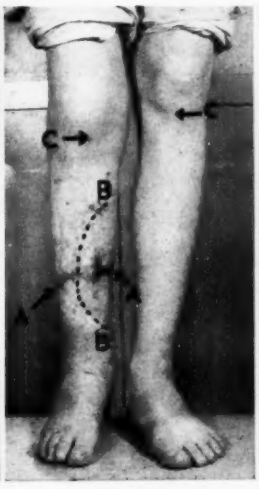


Fig. 8a

Fig. 8b

Fig. 7. Case 1. a and b. Lateral and anteroposterior views 3 months after operation. The graft is still clearly visible. Note the direct firm, bony union between the fragments, almost without callus, the result of the close approximation and accurate fitting of the fragments made possible with apparatus described by reversing its function of traction to obtain actual impaction. Fibula was not disturbed at operation as union was already firm.

Fig. 8. Case 1. a and b. Photographs on day of removal of leg from cast. *A*, Note extent of original soft tissue damage almost resulting in traumatic amputation. *B*, Operative incision followed dotted line. *C*, Shortening due to loss of bone substance compensated by lengthening heel and by slight pelvic tilt. This soldier has been able to perform full military duty without discomfort during the past year.

Fig. 9a. Fig. 9b. Fig. 10a. Fig. 10b. Fig. 11a. Fig. 11b.

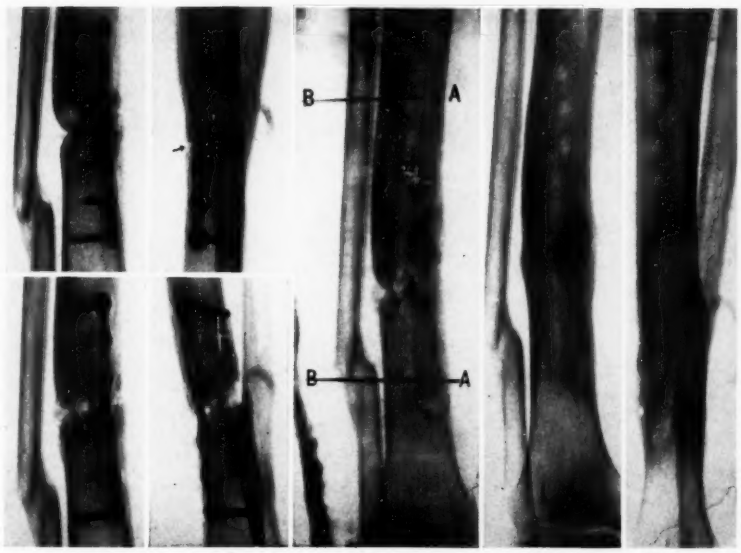
Fig. 9. Case 2. L. P. W., aged 19 years. a, Roentgenogram showing fracture at junction of lower and middle thirds of right tibia and fibula. b, Anteroposterior view in cast 3 months after poor reduction, showing overextension of tibia, arrow, which undoubtedly caused failure of union.

Fig. 10. Case 2. a and b, Anteroposterior and lateral views after removal of cast, 4½ months after injury. The tibia shows no union, the fibula, partial union.

Fig. 11. Case 2. a and b, Fracture plated 8 months after injury.

Fig. 14. Case 3. G. L. G., aged 43 years. a, left, and b, Anteroposterior and lateral views of old gunshot wound of distal third of shaft of radius, left, with loss of 15 inches of bone substance and extensive soft tissue destruction. Injury was sustained 1 year previously. Patient had had 3 operations, including one unsuccessful bone graft during past year, at various other hospitals. Note scattered lead fragments.

custom to prepare the limb 24 hours previously by shaving, washing with ether, iodine and alcohol, and covering with sterile gauze, followed by sterile stockinette, sewed at one end and rolled before sterilization. Any of the various recognized surgical antiseptics may, of course, be substituted for iodine. On the operating table the leg is again prepared by skin antiseptics, after which the Kirschner wires are passed, two through the upper end of the tibia, and one through the lower end or os calcis as desired. The leg is then suspended in the previously sterilized fracture reducing apparatus by fixation of one of the upper wires and the lower wire in the tension bows provided for that purpose. The leg is now draped and the site of non-union is exposed (see Fig. 3a). The technique for the upper extremity is similar, only a different arrangement of the apparatus being required (Figs. 15a, b, and c). A moderate amount of extension is applied to the site of non-union by means of the apparatus and after such fibrous union as may exist is cut through, this extension is increased until the bone ends are separated from one-quarter to one-half inch. The ends may now be thoroughly freshened and properly shaped and then, by reversing the machine, may be fitted together and impacted. In this manner they are held quite firmly without the aid of any manual assistance while a sliding graft is cut or an onlay graft bed is prepared. With this technique the writer most often uses a sliding in-

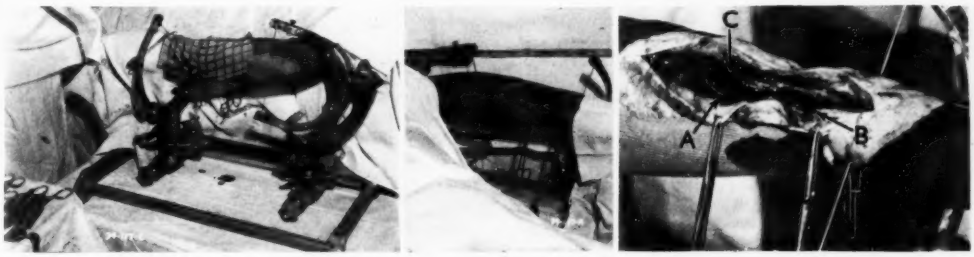


a b Fig. 13a. Fig. 13b. Fig. 13c.
c d

Fig. 12.

Fig. 12. Case 2. a and b, Anteroposterior and lateral views 3 months later, showing no union of tibia, firm union of fibula. Arrow indicates fracture line which is clearly visible. c and d, Three months later and 14 months after injury. Patient had been walking with caliper splint for 3 months. No bony union of tibial fracture is present. Erosion has taken place at fracture site. Note the erosion and absorption of bone about the plate and screws.

Fig. 13. Case 2. a, Anteroposterior view 6 weeks after removal of plate and insertion of inlay bone graft. Union has started. Note both ends of graft fixed by Kirschner wires, *A*, the points perforating skin laterally, *B*. Usually the distal end of the graft is beveled and fitted in the undermined lower end of the bed and does not require fixation. Note screw holes of old plate. Upper and lower extremities of graft indicated by dotted lines. b and c, Anteroposterior and lateral views 6 months later, showing firm union. Patient has been performing full military duty for 3 months.



a b c

Fig. 15. Case 3. a, Left forearm in apparatus, area for bone grafting exposed. b, View of opposite side. (Skin towels removed.) c, Enlargement of operative wound showing defect in radius to be grafted. *A*, End of proximal radial fragment; *B*, end of distal fragment; *C*, ulna intact. Note irregularity of skin caused by dense depressed scarring from loss of soft tissue and skin in original injury and three previous operations.

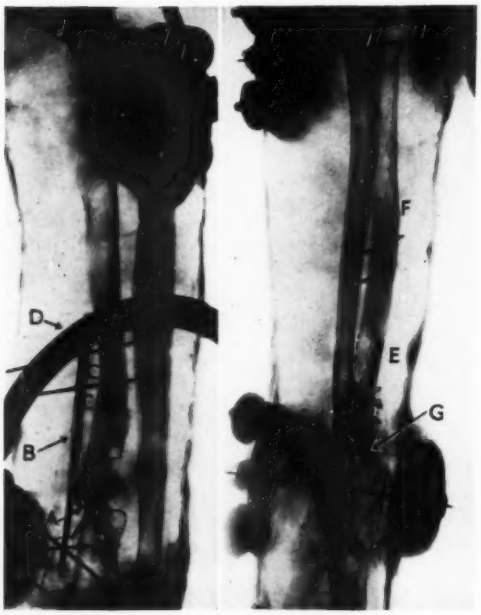


Fig. 16. Case 3. a, Anteroposterior view following bone graft. One inch graft, *A*, placed between fragments. A 6 inch tibial graft, *B*, was imbedded in the radial head and fitted to the lateral surface of the upper radial fragment. A long graft was fixed by two Kirschner wires at either end, the proximal ends of which were brought out to the side of the incision to prevent interference with primary healing. Note the lengthening of the radius accomplished by skeletal traction in the fracture reducing apparatus. Full lengthening was not possible because of the extensive fibrosis and scar contraction. Cellular bone, *C*, on the under surface of graft which is placed tightly against the shaft of the radius casts little shadow and thus gives the erroneous impression of space between the cortex of graft, *B*, and shaft of radius. b, Lateral view after removal of traction bow, *D*, and substitution of aluminum tension holders. *E*, Short tibial graft. *F* and *G*, Upper and lower ends of long tibial graft.

Fig. 17. Case 3. Forearm and arm in cast following operation. Traction bows have been removed. Tension on the Kirschner wires is maintained by aluminum tautners. This case is too recent to show final results but it is presented to illustrate the technique we have described.

lay graft which is easily and accurately cut with a parallel saw while the bone ends are firmly held together by the apparatus. In the use of the sliding graft it is our custom, in fractures in the lower half of the limb, to undermine the lower portion of the graft bed and to bevel the upper portion of the graft to fit this undermined area. In other words, the graft is reversed and the short portion of the graft taken from the lower fragment is replaced to fill the defect in the upper bed. This procedure leaves the lower end of the graft fixed, but the upper end is free in the graft bed and requires mechanical fixation. We have found that a convenient method of fixing this upper end of the graft is to transfix the cortex of the graft obliquely with a Kirschner wire which penetrates the cortex of the parent bone and is carried, usually laterally, out through the skin. The Kirschner wire is then cut flush with the graft (Fig. 5a, *A–B*). This results in a much more firm fixation than can be obtained by any other practical method. When the x-ray film shows that the graft has become fixed in its host and a live portion of the parent bone, the Kirschner wire can be grasped by the point protruding through the skin and easily removed without disturbance of the operative site. Usually this Kirschner wire can be removed by the end of 2 months and the writer has known of no case in which delayed union of the graft or irritation of the bone was caused by its presence. In fact, the firm fixation of the graft which it affords is undoubtedly a contributing factor in the early bony fixation of the graft.

A distinct advantage in the use of such an apparatus as described and the retention of the multiple Kirschner wires for incorporation in the plaster is that the fragments are held firmly together in the cast almost without movement, which is extremely important to a high percentage of success in bone grafting (Figs. 3b and 6). Without the wires imbedded in the cast, tissue atrophy and shrinkage always leave the limb loose in the cast after a few weeks. This same tissue atrophy is our reason for inserting two Kirschner wires

rather than one through the upper end of the bone. We discovered some years ago by rather bitter experience that if one wire or pin is used in the proximal end of the tibia in cases of fracture, this same tissue atrophy would leave the weight of the upper portion of the limb suspended on this one wire or pin. This resulted in such leverage that rotation of the upper bony fragment would frequently take place at this wire, which merely acted as an axle, tending to displace the proximal fragment anteriorly at the site of fracture. When two wires are used, the proximal bony fragment is held in two planes making rotation, and therefore displacement, relatively impossible. We have found routinely that when this method of grafting is used, firm bony union has regularly occurred earlier and with considerably less callus formation than if wires were not used, with relatively much less snug apposition and rigid fixation of the fragments.

CONCLUSIONS

1. A technique is presented to simplify the operation of bone grafting by mechanically separating the bone fragments for freshening and shaping, holding them tightly approximated while the bone graft is cut and fixed, and finally, fixing the fragments immovably in the cast until union is completed. Three illustrative cases appended.

2. A method is suggested for fixation of the free upper end of a sliding bone graft in its bed by transfixion of the graft and cortex of the tibia with a Kirschner wire which may later be removed without disturbance of the wound or the fragment or open operation. In the case of onlay grafts this technique is modified by the passage of a Kirschner wire obliquely and in opposite directions at each end of the graft, the proximal ends of the wire being brought out through the skin to the side of the incision instead of penetrating the limb until the distal end of the wire perforates the skin, as in the case of the sliding graft. The reason for this difference is that in the case of the sliding graft, the wires are passed almost horizontally through the cortex of graft and parent bone without danger of damage to deep vessels, whereas with the onlay graft the wires are passed obliquely posteriorly and should they be allowed to penetrate the soft tissues, might accidentally strike some of the deep vessels with more or less serious consequences.

Photography by U. S. Army Signal Corps, Fort Sam Houston, Texas.

NON-SURGICAL CLOSURE OF VESICOVAGINAL FISTULA

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THE treatment of vesicovaginal fistula is quite generally considered a problem of gynecological or general surgery. However, Kelly, a pioneer gynecologist and cystoscopist, has always stressed the advisability of careful cystoscopic investigation and the routine catheterization of the ureter for protection during the operative repair.

Many operations for the closure of vesicovaginal fistulas are conducted without careful urological study; and certain types of fistulas, which might be closed by more simple urological treatment, are frequently subjected to extensive surgical procedures. Multiple operations often reduce the size of the fistula without affecting the necessary closure that restores normal bladder function. It is generally recognized that the frequency of healing decreases after each operation for repair of these fistulas.

The purpose of this report is to emphasize the possibility of success in closing less extensive defects by cystoscopic and vaginal coagulation of the tract and proper prolonged postural drainage of the bladder by means of an indwelling urethral catheter. This procedure has received little or no consideration in the voluminous literature on the subject of vesicovaginal fistula. One finds no mention of it in standard texts on gynecology. Zabrowski, in a recent article, states that the most important conservative method of treating the fistula is permanent catheterization. Of 45 cases collected from the literature in which this procedure alone was employed, healing resulted in 10. Ottow has advocated electrocoagulation for small vesicovaginal fistulas and recommends that an indwelling catheter be left in the bladder for 10 days. Quinby has reported the final healing of vesicovaginal fistula after cystoscopic electrocoagulation when closure of the defect by surgical repair had not been complete.

The following personal experiences are given in the hope of stimulating more interest in this subject among both urologists and surgeons in general.

CASE 1. In August, 1922, a woman, aged 24 years, who had been suffering from a vesicovaginal fistula for 2 years, was examined. The fistula resulted from incision of the bladder during a vaginal sterilization operation. The latter had been done some weeks after an induced abortion, necessitated by an extreme thyrotoxicosis. Prior to this examination, 2 unsuccessful attempts had been made at vaginal closure by the gynecologist treating her. On each occasion the patient had had a very stormy time and had barely come through the immediate postoperative period. Although the incontinence of urine was complete, cystoscopy showed the fistulous opening to be only about 0.5 centimeter in diameter and located about 1.5 centimeters above and just medial to the left ureteral orifice. Coagulation of the fistula both from the bladder and vaginal sides was suggested with the idea that the fistula might close spontaneously. This was done. A light current was used with just enough desiccation to destroy the epithelial tract thoroughly. The patient returned home and showed no improvement for 1 month, after which time she began to void from 3 to 4 ounces at a time but continued to drain partially through the vagina.

Encouraged by this partial closure, it was believed that if the area of the fistula could be kept relatively dry during the sloughing and healing stage, complete closure might be effected. A bed was prepared in the hospital by cutting a hole in the mattress so that the patient could lie on the abdomen and have an indwelling catheter drain directly into a bottle beneath the bed. The fistula was again desiccated both fore and aft and an indwelling catheter was inserted. The patient maintained a position on her abdomen for 3 weeks, without vaginal leakage. Removal of the catheter showed complete closure of the fistula and bladder function which quickly returned to normal. This patient has remained well. In July, 1928, she had a thyroidectomy performed and is now reported to be in splendid health.

CASE 2. A similar case in which this treatment seemed suitable did not present itself until September, 1928. A woman, aged 48, applied for admission. She had had a vaginal hysterectomy in February, 1926, with resultant vesicovaginal fistula, apparently from the sloughing around a deeply placed chromic catgut suture. One attempt at vaginal closure had been unsuccessful in the hands of a skilled gynecologist. As is well known, vaginal closure in patients previously hysterectomized per vaginam is frequently very difficult. On cystoscopy this patient was found to have a fistulous opening just to the right of the midline, somewhat above the bas-fond and 0.5 centimeter superior to the right ureteral orifice. The fistulous tract admitted a No. 12 F. bougie easily. Coagulation of the area and the tract by inserting the electrode directly into the fistula with a fine desiccating current, insertion of a No. 24 F. mushroom indwelling urethral catheter, and maintaining the patient in a completely upright sitting posture on a specially prepared backrest for 4 weeks resulted in complete and permanent closure of the fistula.

CASE 3. In February, 1936, a woman, aged 58, who had had a supravaginal hysterectomy in October, 1934, was examined. In this instance a deeply placed chromic suture had apparently sloughed through the bladder wall and caused a vesicovaginal fistula.

In March, 1935, an unsuccessful attempt to close this fistula by vaginal surgery was accompanied by a severe ileus and a prolonged hospital convalescence of 3 months. The surgeon in this case was a man of undoubted ability who later advised this patient that he could close the fistula

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by a combined suprapubic and vaginal operation. Because of the difficult convalescence she had had, this patient was loath to enter upon another surgical experience. On cystoscopic examination the fistulous opening admitted a No. 14 F. bougie snugly. The opening was located 0.5 centimeter above and just medial to the left ureteral orifice. A darkened area embedded in the tissue superior to the opening suggested the presence of a piece of chromic catgut. Desiccation both vesically and vaginally was performed in the office and a No. 22 F. mushroom catheter fixed in the urethra. A backrest was purchased and placed on her bed at home; the catheter drained into a bottle at the bedside.

The patient stayed in the upright sitting posture for 4 weeks. She was allowed to stand at the bedside several times each day at which time the catheter was disconnected by the nurse. On removal of the catheter cystoscopic examination showed complete closure of the fistula. This patient has normal bladder function and has been able to resume all her activities, including golf and horseback riding.

CASE 4. In July, 1936, a woman, aged 45 years, presented herself with a condition almost identical with that of the preceding patient. In 1933, a diagnosis of early carcinoma of the cervix uteri was followed by vaginal application of radium. Six months later a total supravaginal hysterectomy was done and the patient developed a vesicovaginal fistula. The gynecologist who operated states that this is the only instance in 2,800 hysterectomies. In July, 1935, the same gynecologist, assisted by a competent urologist, was unsuccessful in closing the fistula by a combined suprapubic, intravesical, and vaginal repair.

Sections of the uterus removed in 1935 had failed to show evidence of carcinoma in the cervix or body of the uterus. In July, 1936, incontinence had been complete since the previous operation. The fistula was situated just above the interureteric ridge 1.0 centimeter medial to the right ureteral orifice. A No. 14 F. bougie seemed to fill about two-thirds of the lumen of the fistula. There was no evidence of infiltration suggestive of malignancy in this region. The fistulous tract was completely coagulated through the cystoscope; the vaginal exposure was unsatisfactory. A No. 24 F. mushroom catheter was inserted in the urethra, and the tubing was attached to a mild suction bottle at the bedside.

The patient maintained an upright sitting posture with slight pillow elevation of the hips for 28 days. On removal of the catheter the patient voided from 150 to 300 cubic centimeters of urine at a time but there was slight dribbling when she was up and about. There was no incontinence when lying in bed. The dribbling ceased in 10 days. Apparently it was urethral in origin and was the result of the prolonged presence of so large an indwelling catheter. Cystoscopy 6 weeks later showed complete healing of the bladder and normal function has continued.

Successful closure in these 4 instances was accomplished by (1) destruction of the epithelial tract and subsequent freshening of the edges; (2) indwelling catheter drainage with postural attempt to keep fistulous area as dry as possible; and (3) continuous acidulation of the urine to prevent lime encrustation of the coagulated tissue. In the last 2 patients described, this was accomplished by an acid-ash diet and doses of ammonium nitrate large enough to maintain a hydrogen-ion concentration of 5.5 or lower.

Two instances of the relation of syphilis to the healing of vesicovaginal fistula are worthy of record.

CASE 5. In January, 1928, a 24 year old society matron stated that in August, 1926, she had been delivered of her first child by forceps and had developed a vesicovaginal fistula. She had been in excellent obstetric hands and the incident had caused considerable embarrassment. In June, 1927, she was operated upon. The fistula was closed for 3 weeks but re-opened with complete incontinence. Examination in January, 1928, showed a very small fistulous opening in the bas-fond midway between the ureteral orifices. Traction on the cervix brought the vaginal opening of the fistula into excellent view. It was difficult to understand why a closure had not been effected. The patient was assured that a perfect repair from the vaginal side could be done.

The operation was so easy and so satisfactory that no attempt was made to keep the area dry by posture, although an indwelling catheter was retained for 3 weeks. The patient voided normally without leakage for 48 hours, after which time partial urinary leakage recurred from the vaginal tract. The results were puzzling and discouraging until an enlarged epitrochlear node was noted and treated. This node had been overlooked but had been recorded on her chart by the interne. The blood Wassermann, previously omitted from the routine, was returned as 4 plus. Re-insertion of an indwelling catheter and intravenous arsphenamine resulted in a complete closure of the tract in 14 days. Subsequent antiluetic treatment and observation until July, 1931, showed no recurrence and serological cure.

CASE 6. In March, 1928, with the previous experience freshly in mind, we were consulted by a Mexican girl, 19 years of age. She was completely incontinent from a small vesicovaginal fistula following her second delivery 4 months previously. The blood Wassermann was 4 plus. The fistula admitted a No. 8 F. bougie and was 0.5 centimeter above and medial to the right ureteral orifice. Intravenous arsphenamine, without indwelling catheter or other local measures, resulted in complete closure of the fistula after 14 days. The patient was observed for another 2 weeks, during which time her bladder functioned normally. She then disappeared and has not been seen since.

CONCLUSIONS

Small vesicovaginal fistulas with healthy surrounding tissue will heal after electrocoagulation, if postural drainage can be maintained with an indwelling catheter for a sufficient period of time. The possibility of this method should receive more consideration, especially in patients upon whom an unsuccessful surgical repair has resulted in a small lateral opening. The method obviously has no place in the treatment of fistulas of the bladder floor or in patients with extensive tissue defects.

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THE VENOUS CIRCULATION IN THE VARICOSE EXTREMITY AND ITS PRACTICAL SIGNIFICANCE

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THE subject of varicose veins has acquired an enormous literature, much of which, however, is a repetition of facts or supposed facts which have followed the original observations of Trendelenburg and Brodie who first pointed out the reversal of blood flow in varicose veins during the assumption of the erect position. A perusal of the present day textbooks and articles on the subject, demonstrates several conceptions which appear to be based more on supposition than on actual fact. These suppositions have been passed down from textbook to textbook and from teacher to student, to the point where they are now accepted as undisputed fact. Because numerous operative procedures have been based on these ideas, some of which are unduly extensive, I would like to examine and discuss the present day clinical information on the subject.

First. In the presence of incompetent valves in the great saphenous vein, there is a reversal of the normal blood flow from above downward in the erect or semi-erect position. This is demonstrated clinically by the Trendelenburg "single" test, which consists of applying a tourniquet lightly about the upper thigh sufficient to constrict the superficial veins only. This is applied with the patient recumbent and the superficial veins emptied by elevation. Then when patient stands and the tourniquet is released the veins fill rapidly from above downward.

This fact is the basis for an understanding of the venous circulation in varicose veins and must always be kept in mind when treatment is instituted. This condition is well shown in Figures 4 and 5, where the radio-opaque solution was injected at the level of the knee with the patient standing, and only those veins distal to the injection were visualized.

Bearing this reversal of flow in mind, one can readily see why the injection treatment in such cases gives inconstant results. Frequently the solution fails to "take" or when thrombosis does occur, recurrences almost invariably appear in the succeeding 5 years. Kettel has reported the follow-up of a series of 225 cases in which patients were treated by injections alone. He reports a recurrence rate of 86.6 per cent over a 5 year period. Other authors have reported similar figures. These recurrences are due chiefly to the dilatation of small collaterals produced by the constant pressure exerted by the reverse flow from above. When a segment of the main vein is blocked, the collaterals above the thrombosed area must enlarge to lead off this reverse flow. Occasionally recanalization is a factor in recurrence. The patient states that she felt relieved for a year or more, and then a new set of enlarged veins gradually appeared. Obviously then the source of this reverse flow must be closed off as the first step in the treatment. This is accomplished by a ligation of the great saphenous vein at the saphenofemoral junction.

This reversal of flow is usually the first feature of importance in a case with enlarged veins, and it initiates a long series of progressively serious difficulties and complications.

Second. It is believed that in greater degrees of varicosity and valve incompetence the veins communicating between the superficial and deep systems also develop valvular insufficiency, and blood regurgitates from the deep to the superficial veins. This is supposedly demonstrated by the Trendelenburg "double" test in which the lower superficial varices fill rapidly (10 to 20 seconds) after patient assumes the erect position and the tourniquet still remains on the thigh. It is argued from this that these varices fill too rapidly for the normal returning venous circulation and, because the reflux has been shut off from above, then these varices fill by blood coming from the deep circulation through incompetent communicating veins. This idea has been extended to the point where masses of dilated superficial veins localized in one area are called a "blow out" point for it is claimed that that is the situation of junction of a large incompetent communicating vein with the superficial circulation.

Anatomically the great majority of the communicating veins are present in the lower leg, although Ochsner and Mahorner (9) have found by their comparative tourniquet test that the veins mainly involved are present in the lower thigh. Theoretically one would believe that if

From the Varicose Vein Clinic of the Royal Victoria Hospital.

incompetent communicating veins were to be found, they would more likely be in the lower leg, both on anatomical and physiological grounds. On the contrary, all the venograms done in the present series showed normal communicating veins in the lower leg, as it was through these that the reversed superficial flow was so rapidly dispersed into the deep circulation. This was true even in the most marked cases of varicose veins showing Trendelenburg "double" test.

While I do not claim that there is no such thing as an incompetent communicating vein, I believe that they are very rarely present and are not of sufficient importance to warrant the extensive operations designed for their removal.

The dissections carried out by Linton are excellent in their demonstration of the communicating veins, but there is no proof that reverse flow does occur through them, consequently the extensive operative procedure which he advocates for their ligation seems unnecessarily severe, and I believe that his results would have been equally good by stopping at the procedure of high ligation and retrograde injection of the great and small saphenous veins.

The presence of incompetent communicating veins is only a supposition based on the interpretation of various clinical tests. It is difficult to prove that they actually exist. The fact that a branch vein penetrating the deep fascia is seen to bleed when cut is no certainty that the blood is coming from the main deep veins, because these communicating veins receive many small collaterals before the valves between the deep fascia and the deep veins are reached.

The phenomenon revealed by the Trendelenburg "double" test can be more plausibly explained by incompetence of the small saphenous vein. The widespread anastomoses between the two veins is well known. Clinically this point can be proved by applying the tourniquet just below the knee after the veins have been emptied by leg elevation. Then on patient's standing, it is seen that the great saphenous vein fills immediately down to the level of the tourniquet, but the varices of the lower leg, which had previously shown rapid filling with the tourniquet around the thigh, now remain collapsed, filling slowly after half a minute or more.

Figures 6 and 7 show that the opaque medium injected into the superficial veins rapidly leaves them and is dispersed by the deep circulation. Normally acting communicating veins are the means of the dispersal.

The clinical applications of the above statement are obvious, namely, that, in the treatment of vein cases showing the Trendelenburg "double" test, both the great and small saphenous veins should be interrupted where they join the deep circulation. I have made this a routine procedure in the past 58 cases showing the "double" test, in which ligation and distal injection with sodium morrhuate solution have been carried out. Twenty-two of these cases had the complication of varicose ulcer. In all of these cases except 6, there has been definite evidence of incompetence of the small saphenous vein. My criteria for stating that incompetence is present are the following: a marked increase in size of the vein lumen; thickening of the vein walls and the fact that a quantity (2 to 4 c.cm.) of the sclerosing solution can be injected retrogradely without any difficulty. When one attempts to inject fluid retrogradely in a vein with competent valves very little can be put in before the vein wall near the cannula begins to distend and the injection is halted. The inclusion in this series of the 6 cases in which these criteria were not present (chiefly the first and third) was probably due to an incorrect interpretation of the original test.

Third. We are instructed by all our textbooks now to interfere with varicose veins when a history of deep phlebitis is present, because these veins are supposed to be a compensatory phenomenon for the blocked deep veins. I believe this conception to be incorrect, because in the majority of cases in which a deep phlebitis has been present, no incompetence of the superficial veins subsequently develops. The leg and foot show edema, malnutrition, eczema, and ulceration, but seldom varicose veins. In those cases in which the two co-exist, the varicose veins probably were present before the onset of the deep phlebitis and may have been a factor in its onset. In such cases when the superficial veins show incompetence of the great or great and small saphenous veins, this fact is a test in itself to show that the deep veins are competent to carry the load of the venous return of the leg, because the reverse flow in the superficial veins in the erect position must be returned by the deep circulation. These superficial veins then are just an added burden on the deep circulation which is taxed to its utmost, and benefit will result from their removal.

That this is the case has been demonstrated by 2 such patients, in one of whom great and small saphenous ligation, and in the other great saphenous ligation were carried out. Four cubic centimeters of sodium morrhuate solution was used in each case and no evidence of further deep vein thrombosis resulted. In both cases there was a marked reduction in the chronic swelling of the

Fig. 1 Fig. 2 Fig. 3

Fig. 1. Injection at the ankle in normal individual while standing. The veins show a normal caliber, straight walls, and no tortuosity. The injected material mounts upward even though subject is standing.

Fig. 2. Roentgenogram showing marked tortuosity, sacculation, and incompetence of the valves of the veins of the lower leg. A periostitis from an overlying ulcer is also present.

Figs. 3 and 4. A marked degree of incompetence with the associated tortuosity and sacculation of the veins of the lower extremity. The dilated associated collaterals are well shown. The leg is almost clear of the injection fluid 30 seconds after the first picture.

leg, and this has been maintained. An ulcer present for 6 years in one of the cases slowly healed, and a marked eczema present in the other case was rapidly relieved.

Fourth. Blood stasis in varicose veins, with its attendant malnutrition, is quoted as the main cause of varicose ulcer. There is no doubt that the peripheral venous circulation in varicose veins is impeded, and this fact has been demonstrated by many investigators, namely: De Takats, Quint and co-workers, and Shaefer, who showed decreased oxygen values and increased carbon dioxide and non-protein nitrogen levels in blood taken from a superficial varix. However, undue stress has been laid on this point in the etiology of varicose eczema and ulcer. This is demonstrated by Figures 6 and 7, in which even though patient was relatively immobile and in the upright posture, the dye had almost completely left the lower leg in less than 30 seconds. We have all seen many cases in which severe sacculated incompetent veins were present for many years with few symptoms and no ulcer.

Undoubtedly, this chronic tissue malnutrition is the basis for the chronicity of varicose ulcer, because on proper removal or ligation and injection of the associated veins, the condition heals

Fig. 4 Fig. 5 Fig. 6

Fig. 5. This patient had had a thrombosis of the great saphenous vein produced by injections years ago. She returned complaining of the formation of new veins. The injection given into the great saphenous vein has been diverted into collaterals. A small part lower in the great saphenous vein appears to have recanalized. The injection fluid left the leg in less than 30 seconds.

Fig. 6. A very severe case of varicose veins showing, besides the usual features, a well outlined popliteal vein and an incompetent small saphenous vein filling from it. The marked degree of involvement and tortuosity of the involved collaterals is also shown.

with remarkable rapidity. However, associated infection in the pre-ulcer area is the actual cause, whether introduced from an abrasion, a broken vein, or the scratching of a patch of eczema.

In the series here mentioned of 22 cases of varicose veins associated with ulcer, the majority healed in 3 weeks, the longest taking 7 weeks. This latter case had had an ulcer for 33 years which had never healed despite all the known conservative methods of treatment. The healing time after the operation of ligation and injection is directly dependent on the length of existence of the ulcer, a longer time being necessary when the surrounding skin is board-like and shows marked devitalization.

VENOGRAPHY

The visualization by means of x-ray of the venous circulation in the superficial veins of the leg has been attempted many times in the past 10 years. The earlier investigators used lipiodol (Quero and Robau, McPheeters, Barber and Orley), but this had the disadvantage of remaining in globules and not giving a homogeneous outline of the veins. Since the introduction of more diffusible preparations, namely thorotrast and the iodine compounds used for intravenous urography, there have been sporadic illustrations of venography in the literature. However, I have been unable to find any articles dealing with the x-ray visualization of varicose veins, in which

any definite series has been investigated. Barber and Camp have written an excellent paper illustrating the uses of direct venography, but have confined themselves to obstructive venous lesions. The radio-opaque solution used in their series was diodrast, with which they claim complete satisfaction.

Fourteen cases selected from the clinic were injected with a medium opaque to the x-ray in order to visualize the extent and communications of their varicose veins. The solution used was hippuran (20 c.cm.) and resulted in no ill effects in those cases which were kept ambulatory. One case selected from the ward patients for a normal control developed a postinjection phlebitis in the great saphenous vein, which resulted in one large and several small pulmonary emboli. After the third such, the saphenofemoral junction was explored and a thrombus was found projecting into the femoral from the saphenous vein and extending up the former for about an inch. The femoral vein distal to the saphenofemoral junction was blocked with clot.

After removal of the proximal segment of the thrombus *in toto* and ligation of the femoral vein at the saphenofemoral level, the patient recovered with no further evidence of emboli. The development of the thrombosis in this case may be explained by the fact that she was not kept actively ambulatory following the injection.

Figures 1 and 2 show the veins in 2 normal cases. There was no evidence radiologically or clinically of varicose veins. The injections were made into the great saphenous vein at the ankle with the patient standing. The solution can be seen ascending as one would expect in veins with normal valves. The veins show normal small caliber, run in almost straight lines, and show no tortuosity or dilatations.

Those cases with varicose veins which were selected showed clinically either a Trendelenburg single or double test; consequently, the injection was made at the level of the knee with the patient standing immobile. Invariably the solution was seen to descend toward the foot outlining the main vein and all its numerous dilated collaterals, and to disappear into the deep circulation through the communicating veins. Within 30 seconds following the completion of the injection and the first picture, the leg was turned to the side for a lateral view, and it was seen that the majority or all of the solution had left the lower leg. In a few of the pictures the popliteal vein could be faintly seen of greater caliber than one would expect, but showing no dilatations or tortuosity. It is reasonable to suppose that the deep veins in a case of varicose veins are dilated because of the increased load put on them by the reversal of flow in the superficial circulation.

Venography in varicose veins would appear to have little clinical use and was done in these instances to substantiate graphically the changes in circulation in the varicose extremity.

PRACTICAL APPLICATIONS

As a result of our investigations and the conclusions therefrom, the following methods of treatment of varicose veins have been adopted in our clinic, whether the complications of ulcer and eczema are present or not.

1. In cases of dilated veins when the Trendelenburg tests are negative or doubtful, local injections of sodium morrhuate or quinine and urethane are used.

2. In cases showing only a positive Trendelenburg "single" test, a ligation of the great saphenous vein is done at the saphenofemoral junction after ligation of the superficial tributaries which join the vein in that region. A distal injection of 4 to 6 cubic centimeters of 10 per cent sodium morrhuate is given into the open vein during the operation. This procedure has been described previously by Faxon, Ochsner and Mahorner (10), Lowenberg, and others. The patient is discharged home immediately after the operation and is kept ambulatory.

3. In cases showing a positive Trendelenburg "double" test—the group which contains the majority of ulcers and markedly involved veins—a saphenofemoral junction ligation of the great saphenous vein is carried out with the distal injection, as described. Also the small saphenous vein is ligated as deep in the popliteal space as it can be traced, and also injected distally with from 2 to 3 cubic centimeters of sodium morrhuate solution.

SUMMARY

The past and present ideas of the venous circulation in cases of varicose veins are discussed and the following points brought out:

1. Emphasis is placed on the basic importance of the reversal of flow in the great saphenous vein with patient in the erect posture, with its bearing on treatment.

2. It is pointed out that the previous conception of the presence of incompetent valves in the communicating veins, resulting in reverse flow, is merely a supposition and is based on few actual facts. The presence of such valves is not substantiated by venographic studies of the leg. Consequently the extensive operative procedures designed for their obliteration are not justified.

3. The existing axiom that varicose veins are associated in a case having a history of deep phlebitis is questioned. Evidence is produced to show that the elimination of the varicosities in such a case will result in improvement of the associated symptoms of swelling, pain, eczema, and ulceration.

4. It is pointed out that blood stasis in the marked degrees of varicose veins is not as great as has been pictured, and, though probably the basic factor in the development of varicose ulcer, is not the actual initiating cause.

5. Treatment of varicose veins and their complications is outlined according to the clinical degree of involvement.

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RETROPHARYNGEAL INFECTIONS WITH ASSOCIATED HEMORRHAGES

A Rationale of Procedure for a Standardized Operation

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THE relatively rare occurrence of severe and fatal hemorrhage associated with retropharyngeal infections very often leaves the attending physician bewildered when he is confronted with such a condition: he too frequently finds himself helpless as his patient suddenly expires from exsanguination. Undoubtedly, each year many patients are lost because of inadequate dissemination to our profession of knowledge of that simple procedure which has been proved most adequate in these catastrophes.

In reviewing the literature of this condition, one is impressed by the scarcity of material in textbooks and journals which might reach the average physician. Many of the articles submitted are reports of a few isolated cases, usually fatal, with incomplete conclusions drawn. The most significant articles are those by Lebram in 1906, Newcomb in 1908, Lubbers in 1912, Stumpf in 1920, Sercer in 1928, Lifshutz in 1931, Le Mesurier in 1931, Skoog in 1932, Gerlings in 1932, Brauer in 1933, Salinger and Pearlman in 1933, Stein in 1933, Goodyear in 1936, Fetterman and Pritchard in 1939.

Salinger and Pearlman reported the collected case histories, treatment, and findings at necropsy in 231 cases, and gave a complete review of this subject to date. Probably the most comprehensive pathological and bacteriological study of this condition is to be found in the article by Stein, who submitted detailed reports of gross and microscopic studies from 14 autopsies which came under his own observation.

The pathological state which allows this serious complication to develop is one of severe infection of the retropharyngeal spaces. The invading organisms usually are of the streptococcic group, although they are often associated with other flora from the mouth, such as the Bacillus fusiformis and the spirochæta (14). The severe hemorrhages which may follow are the result of secondary involvement and erosion of the blood vessels traversing this infected area.

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It is evident that there is a very close anatomical relationship between the branches of the common carotid artery and the internal jugular vein with the abundant lymphatic system collected in these spaces. The numerous lymphatics which drain through this area must subject the region to constant infection of varying degrees. The more plentiful lymphatic system in children, as well as their greater susceptibility to upper respiratory disorders, limits these complications of retropharyngeal infections largely to childhood.

The blood vessels are involved by a process of direct extension. It is accepted that blood vessels have a remarkably high resistance to severe neighborhood infections, and succumb only after prolonged assault by virulent organisms. The veins usually react by thrombosis of their lumina. The arteries, however, seldom become thrombosed, probably because of their more thickened, resistant coats, and the more rapid, pulsating flow of blood through them. Occasionally, however, there is complete, direct infiltration through the arterial wall, with resultant rupture, often through a pseudo-aneurismal sac. With the first leakage of blood, usually there is an increased swelling in the neck and retropharyngeal region. Swelling in the latter area often is wrongly interpreted as resulting from a retropharyngeal abscess, and occasionally is opened, with disastrous results from sudden fatal hemorrhages. Within a few days the pressure of the infected blood ruptures through a small opening in the pharyngeal mucous membrane, giving the first warning of approaching danger. As the small opening in the pharyngeal mucous membrane becomes larger, there is release of the internal pressure provided by clots, etc., within the closed retropharyngeal space, which previously controlled the hemorrhage. With this release, more profuse and often fatal hemorrhage occurs. The records reported show that these severe and fatal hemorrhages usually have been preceded by a slight discharge of blood. The hemorrhage generally occurs from the pharynx, although in 8.7 per cent of the cases reported the blood escaped directly into the internal or external auditory canal.

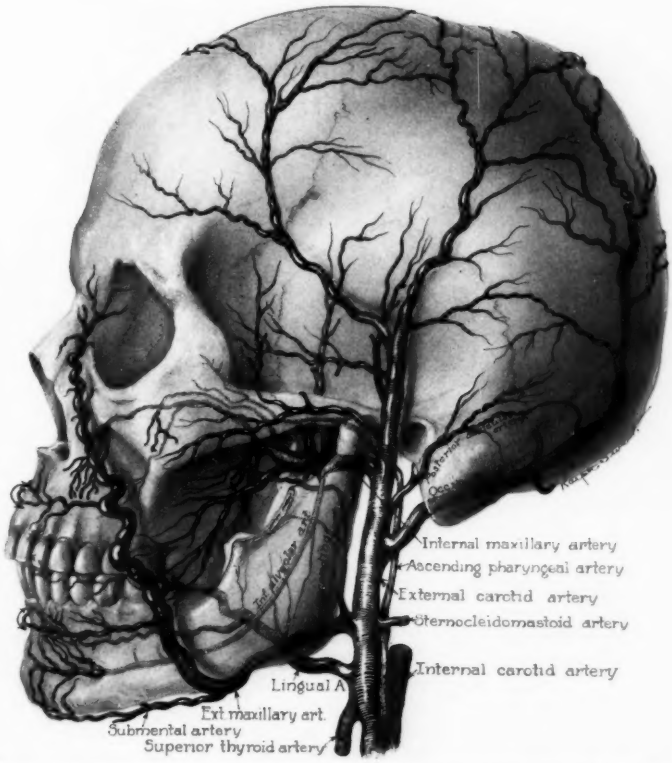

Fig. 1. External carotid artery, showing abundant collateral circulation with opposite external carotid.

In a series of 76 autopsies (11), in which death was proved to have been the result of erosion of a large vessel, either the internal carotid or the common carotid artery was "eroded" in 76 per cent, while the external carotid and its branches were the sources of hemorrhage in only 24 per cent.

Studies made at autopsy (14) show that, while the internal carotid very frequently is involved directly, hemorrhage from the external carotid usually arises in one of its several branches. The closer association of the lymphatic glands with the internal carotid and the branches of the external carotid artery probably accounts for the more frequent involvement of these vessels.

CASE REPORTS

CASE 1. S. B., male, aged 9 years, was seen on April 15 1935, in consultation with Drs. Clain F. Gelston and Wallace Smith at Children's Hospital, San Francisco.

On April 8, 1935, the patient complained of a stiff neck and sore throat. A tender, hard swelling the size of a bean developed behind the angle of the right mandible. His temperature was 103.5 degrees F. Two days later, he developed the typical rash of scarlet fever. On the seventh day of his illness (April 15), while he was drinking some milk, the patient had his first pharyngeal hemorrhage, estimated at 300 cubic centimeters and was taken to the hospital immediately. Blood analysis showed: hemoglobin, 70 per cent, red blood cell, 3,470,000; white blood cell, 14,500; with 88 per cent polymorphonuclear cells.

Physical examination at this time revealed a rather sick boy. In addition to the findings noted there was a swelling in the posterior pharynx and a blood clot extruded through a small opening behind the right posterior pillar.

The right *external* carotid artery was immediately ligated and severed in continuity. This was carried out under nitrous oxide anesthesia.

On the following day the blood pressure was 140/60, and temperature 102 degrees F. At 6 p.m. a fresh hemorrhage occurred, and the opening in the pharynx had become wider. At this time the hemoglobin was 48 per cent; red blood cells, 3,200,000; white blood cells, 12,500; with 90 per cent polymorphonuclear cells.

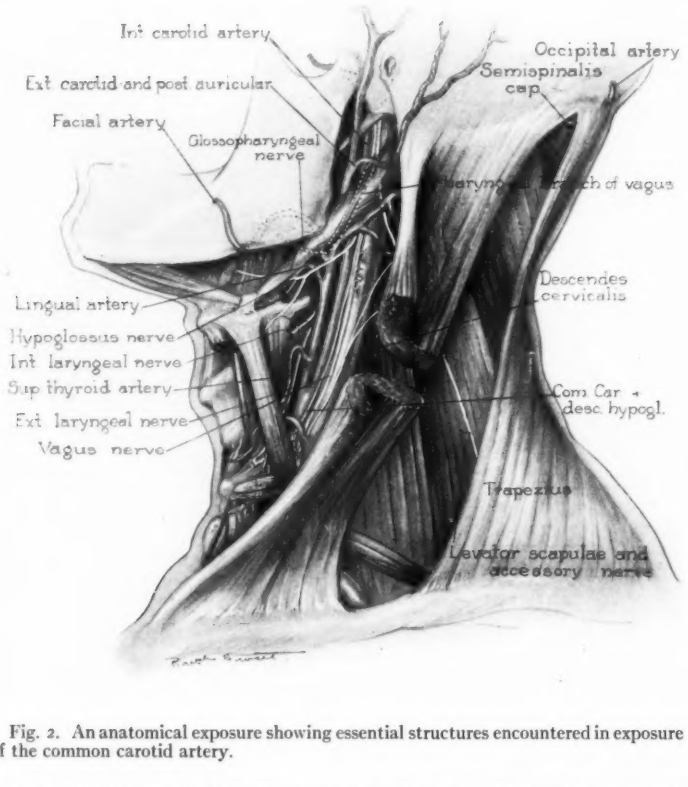

Fig. 2. An anatomical exposure showing essential structures encountered in exposure of the common carotid artery.

Under nitrous oxide anesthesia, the right common carotid artery was then ligated and severed in continuity, and a transfusion of 200 cubic centimeters of whole blood was given. On April 23, the fifteenth day of his illness, there was a sudden hemorrhage amounting to 500 cubic centimeters. The pulse became rapid and weak; the child was kept under sedatives. The next day the findings were: temperature, 104 degrees F.; pulse, 140; blood pressure, 126/50; hemoglobin, 38 per cent; red blood cells, 2,300,000; white blood cells, 16,800; 90 per cent polymorphonuclear cells. Marked pulsation was noted at the site of the ligated external carotid artery. Exudate from the suppurating neck wound was cultured and showed streptococci. The patient was kept quiet with sedatives. On April 26, his blood pressure was 136/50, and temperature 102.6 degrees F. The child was restless. At 4:30 p.m. an almost exsanquinating hemorrhage of over 1000 cubic centimeters occurred. The patient was pulseless, unconscious, and mildly convulsive. A transfusion of 250 cubic centimeters of whole blood was given immediately, with temporary recovery. Seven hours later, a second transfusion of 200 cubic centimeters of whole blood was given, and under light nitrous oxide anesthesia the operative field was again explored.

It was found that the previously ligated common carotid artery was collapsed. The distal stump and remaining portion of the external carotid artery and its branches had enlarged greatly (diameter 0.75 cm.) as a result of collateral circulation which had developed from the opposite external carotid artery. This distal trunk of the external carotid artery was completely excised after the major branches were ligated. The patient's recovery was rapid and complete, without residual disability, except for a slight Horner's syndrome which gradually disappeared entirely.

Case 2. A. G., male, aged 8 years, was seen at home on March 27, 1939, in consultation with Dr. Walter Birnbaum.

In the early part of March, 1939, the patient had an attack of acute tonsillitis with submaxillary lymphadenitis. Under treatment, the tonsillitis subsided, but the adenitis persisted. The submaxillary and anterior chain of cervical lymph nodes persisted as slight, tender, discrete, movable masses varying in size from 1 to 3 centimeters in diameter. The patient had a low grade fever, varying from normal to 100 degrees F. by mouth. He was treated at home in bed by usual conservative measures, including local applications of moist heat. No sulfanilamide was used.

The patient's temperature having become normal after about 2½ weeks, he was allowed to be up. On the afternoon of March 27, 1939, he was to leave the house for the first time, when he expectorated a small amount of bright

red blood. He lay down for 2 hours when, at 4 p.m., he had a sudden severe hemorrhage from the mouth of about 500 cubic centimeters. He was taken to St. Joseph's Hospital at once, where his blood count showed: hemoglobin, 64 per cent; red blood cells, 3,375,000; white blood cells, 25,200; 84 per cent polymorphonuclear cells.

Examination at this time revealed the classical findings of acute hemorrhage, and on the right posterior pharyngeal wall a small exuberance of granulation tissue, resembling a rose bud, in the center of which was a clot of blood. Fresh blood was present in the oral cavity. There was no evident edema or sign of inflammation in the pharynx. The tonsils were moderately enlarged and chronically infected. The submaxillary and cervical lymph nodes were as here described. The temperature was 99.8 degrees F. rectally; pulse, 128; and respiration, 24.

Operation was performed the same day under gas and ether anesthesia. After the superficial veins were divided, the common carotid, ascending pharyngeal, superior thyroid, lingual, facial, posterior auricular, occipital and terminal portion of the external carotid were ligated and divided.

The postoperative course was uneventful. The wound healed *per primam*. A low grade fever persisted until the day before discharge on the tenth postoperative day. Anti-anemic measures were instituted.

TREATMENT

In view of the past experience and errors of competent observers, it is generally conceded that these fatal hemorrhages arise from some major branch of the common carotid artery. It is also believed that the internal carotid probably is involved most often (in 76 per cent of cases), although autopsy records show that the external carotid or, more often, its branches, and the ascending palatine artery, are frequently the source of bleeding (in 24 per cent of cases). If we acknowledge these proved facts, the only rational therapy is prompt ligation of the artery involved, proximal to the source of the hemorrhage. This ligation offers the best assurance against recurrent fatal hemorrhages and propulsion of fatal emboli to the brain. Any patient with retropharyngeal infection presenting the complication of slight bleeding from the pharynx or ear should have prompt ligation of the carotid artery before the inevitable exsanguinating hemorrhage occurs. Any attempt to arrest the bleeding through the pharynx usually is meddlesome surgery.

In a given case, which artery should be ligated? It is impracticable to expose adequately all the vessels which might be eroded in the retropharyngeal spaces in order to visualize the bleeding point. In these acutely ill patients the region is obscured by enlarged lymphatic glands and surrounding infiltrated tissue, a condition which contra-indicates any unnecessary dissection.

Under light nitrous oxide or local anesthesia the common carotid artery and its major branches can be exposed easily (Figs. 2 and 3). The internal

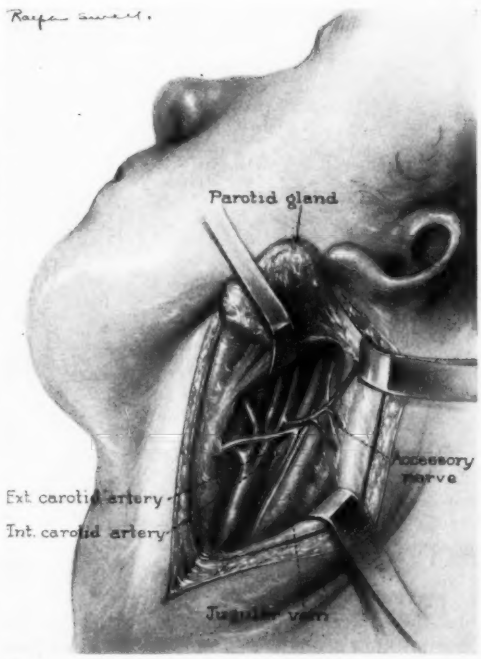

Fig. 3. Surgical approach to the common carotid artery.

carotid artery can be visualized for a considerable distance, and the external carotid artery can be exposed so that its various major branches are visible. In very rare instances the portion of the artery actually eroded will be accessible, in which case the obvious treatment is ligation both proximally and distally.

If a vessel is to be ligated, it is generally conceded a better surgical principle to ligate it doubly and to sever the continuity of the vessel between the two ligatures. This procedure prevents the re-establishment of circulation, which often occurs when an artery is ligated in continuity. In addition to this ligation of the main artery, it is safer also to ligate its major branches in order to prevent an annoying collateral circulation which usually establishes itself within 7 days. Such a newly established collateral circulation has been proved to be the cause of recurrent hemorrhages and of cerebral complications resulting from the dislodgment of thrombi originating in the main trunk (3).

The incidence of hemiplegia following ligation of the common or internal carotid artery (2), while a serious complication in adults, is negligible in children. The child has a very abundant

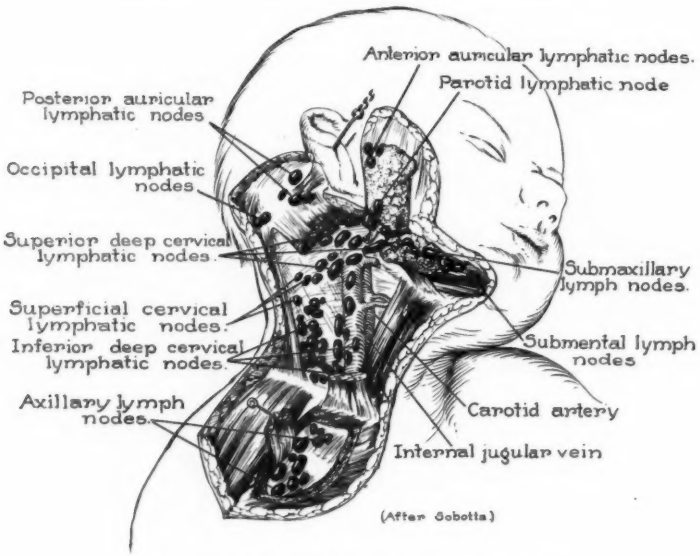

Fig. 4. Deep and superficial lymphatics. After Sobotta.

collateral circulation through more elastic and less tortuous arteries. The necessity for controlling an otherwise fatal hemorrhage more than offsets the very slight danger of incurring cerebral complications.

The author feels that all ligations should be accomplished at the first operation if possible. At any secondary procedure, the operative field is masked by fibrin and streptococcic suppuration, and this masking makes dissection and identification of important anatomical structures both difficult and surgically hazardous.

On account of the very limited experience of any one surgeon in this particular disease, a standardized technique has not yet been established. Three possible sites for ligation have been described, with arguments for and against them:

1. *Primary ligation of the common carotid artery alone.* Technically, this operation is the most simple on account of the low cervical location of the operative field, which affords easy exposure of the common carotid artery. Theoretically, ligation of the common carotid artery should be adequate to control distal hemorrhage in either external or internal branches and in the ascending palatine artery. Practically, however, ligation of this artery has proved inadequate because of the abundant collateral circulation between the external and internal branches at the site of bifurcation of the common carotid artery.

2. *Ligation of the internal carotid artery alone.* Much evidence (11, 14) points to the internal carotid artery as being the vessel eroded in most instances (76 per cent). If we could be absolutely certain that the bleeding was from the internal carotid artery, it is obvious that its ligation should suffice. There is, however, a possibility in 24 per cent (11, 14) of cases that the hemorrhage is not from the internal carotid, and hence in such cases its ligation alone would be valueless.

3. *Ligation of the external carotid artery alone.* Here, again, for lack of evidence, we are not warranted in assuming that the obscure hemorrhage arises from the external carotid artery. Our chances of an error are 76 per cent (11, 14). Even were we correct in ligating only the external carotid artery, it is evident that the collateral circulation from the opposite side may re-establish the hemorrhage, as illustrated by Case 1, in which a primary ligation of the major branches would have avoided the third hemorrhage. In view of the experience in Case 1, a fourth technique is suggested which seems to be a more logical procedure in the presence of uncertainty as to the source of hemorrhage, and which was practiced in Case 2, as reported. Because of the evident difficulty in determining before operation the exact source of the hemorrhage, and also because of the more frequent incidence of involvement of the internal carotid artery, it is probably better judg-

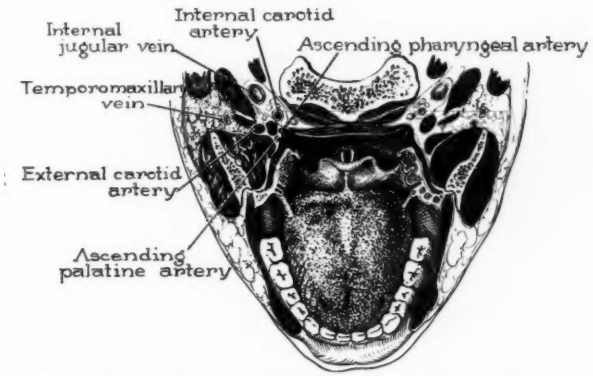

Fig. 5. Horizontal section through mouth and pharynx at level of tonsils. After Goodyear.

ment to ligate the common and external arteries, together with the major branches of the latter.

4. Ligation of the common carotid artery, the external carotid artery, and the major branches of the external carotid artery. In view of our experience in Case 1, the author recommends this procedure as a prophylactic measure at the original operation, as illustrated in Case 2. This assures control of bleeding, whatever the source, and at the same time eliminates the possibility of recurrent hemorrhages through collateral circulation from the opposite carotid artery. In our first patient, we assume that the first hemorrhage arose from the external carotid artery and was controlled by ligation of this artery. The second hemorrhage after 36 hours probably issued from the internal carotid or from the ascending palatine artery and was controlled by ligation of the common carotid artery. The third, and almost exsanguinating hemorrhage 7 days later, undoubtedly was the result of abundant collateral circulation through the opposite external carotid artery. This assumption is based on the fact that at the third operation the previously ligated common carotid artery was found to be collapsed, while the severed distal end of the external carotid artery and its branches was markedly dilated throughout. This third hemorrhage was controlled by ligation of the branches of the external carotid artery.

These ligations, as shown in the accompanying diagrams, require a negligible increase in the time needed for operation and produce little or no additional shock to the patient. An excellent exposure of the common carotid artery and its major branches is achieved through an incision beginning at the mastoid process and developed along the anterior border of the sternomastoid muscle (Figs. 2 and 3). Such a technique of primary multiple ligations would have avoided the last two operations in Case 1. These multiple ligations of the common carotid artery, as well as of the external carotid and its major branches, were the composite technique which undoubtedly saved the patient's life. The clinical risks and surgical difficulties encountered in these 3 separate operations could easily have been avoided had the multiple ligations been performed in one stage, as reported in Case 2.

As a conservative concession to this radical procedure, the author suggests: (a) An excision of the external carotid by ligation of all its branches; (b) a heavy silk ligature placed about the internal carotid with its ends brought out through the wound, this ligature to be immediately tied if further bleeding occurs from the internal carotid artery.

SUMMARY AND CONCLUSIONS

1. Retropharyngeal infection is likely to cause erosion of some branch of the common carotid artery.

2. Any patient with such an infection, who has even a slight hemorrhage from the pharynx or auditory canal, requires immediate ligation of the common carotid artery and its branches.

3. The possible types of ligation in the condition under discussion are reviewed, and the following procedure is recommended at the initial operation: Ligation of (a) the external carotid artery; (b) all major branches of the external carotid artery; (c) the internal carotid artery. This may be deferred by placing a silk ligature for secondary ligation, if necessary.

4. The same surgical principles are involved in controlling hemorrhages from other sources as a result of malignancy, trauma, gunshot wounds, and other lesions.

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RUBBER HEELS FOR WALKING CASTS

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SINCE the introduction of walking casts, many varieties of attachments to provide the weight bearing surface have been devised. After trying many of them we find the one here illustrated most satisfactory from the standpoint of economy, appearance, ease of application, and efficiency. It consists of an entire heel, leather and rubber, applied to the bottom of a reinforced cast, and held in place by means of webbing attached to the heel and incorporated in the plaster.

Rubber heels are cheap. Every shoe store and appliance shop has a basket full which have been removed from shoes for replacement by Thomas heels. They are easily applied at one sitting; no drying period between the application of the cast and the heel is necessary; and no bending irons are required.

From the Orthopedic Service, Department of Surgery, University of Michigan.

The finished cast is smooth and neat in appearance. A stocking may be slipped over the cast and a hole cut for the heel.

In winter a wool sock or an overshoe can be worn.

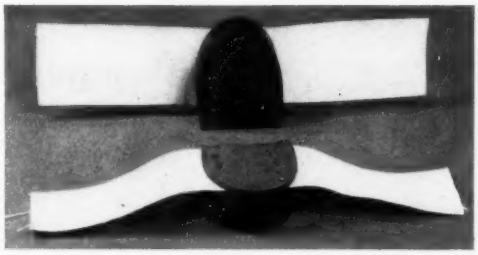

Fig. 4. Details of construction of heel. The top layer of leather is pried off, the webbing inserted, the leather reapplied, and the nails turned down.

Fig. 1

Fig. 2

Fig. 3

Fig. 1. A light, skin-tight cast is applied with foot at right angle, lined only at margin with stockinette.

Fig. 2. Sole is reinforced, hollow of arch filled in, and surface flattened for the application of the heel which is placed just back of mid-foot on a plane that is at right angles to the weight bearing line.

Fig. 3. Heel fastened in place with a few more turns of plaster bandage. Weight bearing is allowed after 24 hours if cast is thoroughly dried. If a long leg cast is used, the heel and sole are built up on the opposite shoe.

Patients who have also worn the various modifications of the Boehler iron prefer the rubber heels because there is sufficient bearing surface to give them a good grip on the floor for stability and still allow a rocker motion in walking.

Care should be exercised to put the foot in the cast at right angles to avoid striking the ball of the foot on the floor in walking. One roll of plaster is sufficient to reinforce the bottom surface and fill in the hollow of the arch. The flat surface thus provided for the heel should be at right angles to the weight bearing line. If a long leg cast is used, the heel and sole of the opposite shoe are built up ½ inch.

After using more than 100 of this type of weight bearing casts in various types of corrective, arthritic, traumatic, postoperative, and infectious cases, we feel justified in recommending it to the profession.

THE TREATMENT OF VARICOSE VEINS BY HIGH DIVISION AND RETROGRADE INJECTION

A Review of 135 Late End-Results

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Boston, Massachusetts

SINCE the statement by Homans, in 1916: "Varicose veins and their attendant ulcers have long offered and may continue to offer a fruitful field for surgical failures, and this not so much from the lack of effective weapons in the surgeon's armamentarium as from his failure to choose his weapon according to the strength of his opponent," the pendulum of therapy has swung widely, particularly during the past decade (5).

After a long period of radical surgical procedures including excision and stripping, an era of non-operative or simple injection treatment was ushered in with eagerness and satisfaction. Thus, radical surgery frequently associated with serious complications and long costly hospitalization was abandoned for a relatively safe, ambulatory method.

Careful studies soon demonstrated an enormous percentage of recurrences after simple injections, particularly in those cases in which there was extensive dilation in the saphenous system above the knee. The cause of this rapid recurrence was obvious when one considered that the injection treatment could not affect the major source of leakage at the saphenofemoral junction.

It was inevitable, therefore, that the importance of high interruption of the saphenous vein should be recognized anew and combined with the injection treatment. The correction of back pressure was again shown to be the most important single factor in treatment. Homans, in 1916, had stressed this principle in connection with the radical operative methods in vogue at that time. Retrograde injection complements the ligation; it obliterates the trunk in the thigh and lessens the number of injections needed below the knee.

Treatment, based upon these principles, was begun in the vascular clinic of Beth Israel Hospital in late 1932. In this paper we propose to make a survey of 135 extremities treated in this manner for the purpose of evaluating those which proved failures.

The selection of cases, method of examination, contra-indications, etc., have been adequately reported (1, 2, 7) and need no elaboration in this paper. We are describing our technique in detail, however, because of its obvious bearing on end-results (Fig. 1).

TECHNIQUE

After adequate preliminary sedation, the operation is performed under a local anesthesia of 1 per cent novocain with adrenalin. The intradermal infiltration is begun over the femoral pulsation, about ¾ centimeter below the crease in the groin, and extends medially parallel to this crease for a distance of 4 to 5 centimeters. The incision is carried down through subcutaneous fat and superficial fascia. Then, by vertical

From the Department of Surgery, Harvard Medical School, and the Vascular Clinic of the Beth Israel Hospital.

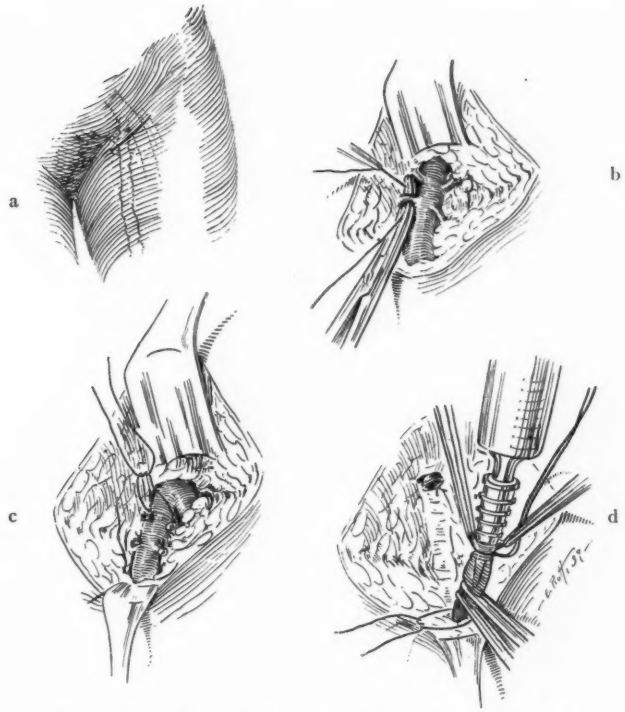

Fig. 1. Operative technique. a, Incision 0.5 centimeter below crease in groin; b, ligation of all tributaries; c, ligation at saphenofemoral junction; d, injection down distal stump.

scissor dissection, the saphenous vein is usually found in the medial portion of the wound.

A ligature or tape may be placed about the vein for traction while the vessel is dissected upward and downward. From 2 to 12, usually an average of 5, tributaries have been found entering the saphenous vein, chiefly just before and at the point where the vein passes through the fossa ovalis. All of these tributaries are severed between fine silk or plain No. 00 catgut ligatures. The saphenous vein is doubly ligated, above the highest tributary, at or near the saphenofemoral junction with heavy silk or No. 0 chromic catgut.

The vein is thoroughly exposed in the lower portion of the wound and any tributaries are ligated and severed. The wound thus contains a segment of vein about 4 to 6 centimeters long. The upper two-thirds of this segment is excised and a special Faxon grooved cannula is tied into the open end. Loss of 20 to 30 cubic centimeters of blood through the open end of the vein may be of some value in connection with the subsequent chemical sclerosis.

The wound must be protected by wet gauze against the accidental spillage of sclerosing solution. Depending upon the size of the varices, 10 to 30 cubic centimeters of varisol[1] is injected slowly and with slight pressure. The solution will exert its effect chiefly on the saphenous vein in the thigh if an assistant maintains pressure over the saphenous vein in the region of the knee[2] for 5 minutes.

After the injection, before the cannula and syringe are removed, a right-angled clamp is placed across the vein just below the tip of the cannula. The vein is doubly ligated ¼ centimeter below the clamp. If the vein is cut along the lower border of the clamp, no leakage takes place; the clamp, cannula, and syringe are re-

[1]Formula: 30 per cent invert sugar, 10 per cent sodium chloride, and 1 per cent benzyl carbinol (Abbott).

[2]Alternate method: Apply a woven bandage from toes to knee prior to the operation.

Fig. 2. End-results of 135 high ligations with retrograde injection studied 2 to 6 years after operation.

moved as a unit. The wound is flushed with warm salt solution and then closed.

Postoperative care. At the conclusion of the operation, the extremity is elevated, and the thigh, leg, and foot muscles are exercised. After being transferred to bed, the patient is encouraged to elevate and move the leg frequently, but we have not insisted that the patient be ambulatory immediately. On the afternoon of the day of operation the patient is up and about and is usually discharged the next morning.

In about 80 per cent of these patients the saphenous trunk in the thigh is thrombosed at the time of discharge; and, in many, this is noted at the conclusion of the operation. This thrombosis we assume to be associated with more extensive intimal damage, and, therefore, more lasting than the thrombosis which results from the injection of lesser amounts of sclerosing solution, e.g., 1 to 2 cubic centimeters of sodium morrhuate.

The patient is instructed to continue activity and to wear supporting bandages after discharge from the hospital. One week later the patient returns to the out patient clinic for removal of sutures and for the first of any injections needed in the leg or lower thigh. On the average 3 to 4 injections are required for each extremity. A small number of patients need no injections because of thrombosis of the saphenous vein from groin to ankle.

METHOD OF END-RESULT STUDY

Letters were sent to all patients who had been subjected to this procedure at least 2 to 6 years previously. In response to 130 requests, 18 were returned because of wrong address, 25 were ignored, and 87 patients, representing 135 operations, reported. Each was questioned concerning relief of symptoms and the entire lower extremity was carefully inspected and tested by palpation, tap, and tourniquet test.

We were concerned chiefly with anatomical end-results, inasmuch as symptomatic relief usually followed obliteration of the varicose system.

End-results. We have separated our results (Fig. 2) into 3 arbitary groups as follows:

1. "Perfect" signifies that the extremity was entirely free from varicose veins. Obliteration was complete in the major system and all its varicose tributaries. There were 29 extremities or 21.4 per cent in this group.

2. "Good" denotes that the great saphenous system was entirely thrombosed but that there was some dilation and stagnation in tributary veins or segments of the latter. This may have been due to recurrence, inadequate follow-up injections, or the formation of new varicosities from previously uninvolved veins. In any event, the situation could be remedied by a few injections. Anatomically and symptomatically these were satisfactory end-results. There were 81 extremities or 60 per cent in this class.

3. "Failure" includes any extremity in which a greater or lesser portion of the great saphenous vein itself was patent, and of course any case in which there was persistence or recurrence of ulcer. In some, the entire vein contained blood despite a lessened diameter and a partial or complete absence of symptoms; in others, the segment containing stagnant blood was not more than 2 to 3 inches long. This group consisted of 25 extremities or 18.5 per cent and included 5 recurrent or persistent ulcers.

CAUSES OF FAILURE

An analysis of our failures revealed definite reasons in the majority of instances, and many were avoidable.

1. *Faulty technique (2 instances).* In none of our cases could we find evidence of backflow via a tributary above the point of ligation. In 1 of our obese patients the house surgeon did not find the saphenous vein and the patient refused reoperation. In another it was obvious that recurrence was due to failure to sever an atypical tributary which connected the saphenous vein with a large suprapubic varix.

2. *Incompetent communicating veins (3 instances).* Damage to the valves of 1 of the veins

which connect the deep and superficial systems will result in a reversal of blood flow through the communicating or perforating vein. The flow will then be from the deep to the superficial system. This reversed flow constitutes an abnormal head of pressure which is not affected by high ligation, but which itself may hasten recanalization in the thrombosed superficial system. These incompetent communicating veins usually follow deep phlebitis and are found most frequently in the lower leg; we have found them less frequently in the lower and mid thigh.

Inadequate obliteration of an incompetent short saphenous system, associated with varicosity of the long saphenous system, may cause failure, although there was no instance in our series. The mechanism is not unlike that referred to in the preceding paragraph, for indeed the short saphenous vein perforates the fascia and enters the deep system. We have ligated such markedly dilated short saphenous systems in the popliteal space.

3. *Inadequate postoperative injections* (*9 instances*). Inasmuch as high ligation and obliteration of the varices by injection complement each other, it was to be expected that we would find failures among those who did not return for completion of the sclerosing process. Our survey revealed that 6 did not return because of the relief afforded by the ligation itself; 2 lived in distant communities and failed to visit their family physician for the injections. In 1 patient injection was precluded by a diffuse eczema.

4. *Pregnancy* (*3 instances*). The effect of subsequent pregnancy on high ligation is not uniform and will be reported in another paper. Two of the women who came back for this follow-up were in the last trimester of pregnancy. Marked varicosities were seen on 3 extremities and moderate varicosities on 1 extremity. It would appear, then, that pregnancy may cause failure, although only temporary in some.

5. *Unknown* (*8 instances*). We were unable, either by study of the record or physical examination, to determine the cause of failure in this group.

EVALUATION

Eleven or 44 per cent of our 25 failures were probably avoidable, namely, those due to inadequate surgery or insufficient postoperative injections.

The 3 failures associated with incompetent communicating veins, if the latter were present before operation, might possibly have been avoided by a more careful performance or interpretation of the tourniquet test. Can the method of treatment, however, cause incompetency of these communicating veins? It is conceivable that sclerosing solution, injected into the saphenous vein at the time of operation, may enter a previously normal communicating vein in a concentration sufficient to damage the latter's valves, with the eventual deleterious effect on the superficial system herein described. The following history is pertinent to this problem:

Mrs. S. M., aged 37 years. On October 10, 1934, a left high ligation with retrograde injection was done; 8 tributaries were ligated and divided. When she reported at the vascular clinic for routine postoperative check-up, no injections were given because the saphenous system was completely thrombosed. On July 17, 1936, she was rechecked and her extremity was described as "excellent except for an occasional small, dilated, superficial vein." On February 7, 1938, recurrence was noted in the entire saphenous vein up to 2 inches of the operative scar. The saphenous system, although completely filled by a regurgitant column of blood, was less dilated than before the original high ligation; it was likewise the source of less discomfort. Re-operation on May 6, 1938, revealed the source of the reflux to be a communicating vein about 1½ inches below the previously ligated distal stump of the saphenous vein. It is possible that this communicating vein was not incompetent at the time of the first operation and that its valve system was injured by the sclerosing solution.

The group of 8 failures of "unknown" cause and representing 5.9 per cent of all the operations deserves special concern. We have already emphasized the important fact that new varices may appear in previously normal tributaries, regardless of the extent or type of therapy. This is one of the reasons why the majority of our end-results are "good" rather than "perfect." But a failure due to the re-opening of portions of the thrombosed main trunk itself, after high ligation and injection, and in the absence of incompetent communicating veins, implies an inherent weakness in our method.

Of great significance, in this connection, are the studies (4, 6, 9), which show how a chemically thrombosed segment re-opens, in contradistinction to the natural reparative processes which follow postoperative, traumatic, or so called spontaneous thrombosis. Sections of a varicose vein removed 24 to 48 hours after injection, regardless of the solution, show that the solid mass filling the vein varies in firmness and structure in different portions of a single specimen. Deposition thrombus, attached to damaged intima, forms the smaller portion of the total occluding mass while the larger portion consists of simple, unattached coagulation thrombus and usually is in relation to undamaged intima. If retraction of the clot is so extensive that the resulting space communicates between 2 tributaries opening into

the principal lumen, the vessel once again is part of the active circulation with the potentiality of undergoing still further varicose dilation. In other specimens, it was observed that solid buds of proliferating endothelium from uninjured intima grow into organizing thrombi and form sinuses which become confluent and so re-establish the lumen of the vessel.

Pratt has reported a technique which may be helpful in certain cases. He distributes the sclerosing solution equally throughout the vein length via a ureteral type of catheter introduced for a distance of 40 to 60 centimeters.

Thus, more permanent obliteration and a better result may follow any method which causes uniform intimal damage with a resultant continuous and diffusely attached thrombosis.

SUMMARY AND CONCLUSION

1. One hundred and thirty-five extremities in 87 patients were studied 2 to 6 years after high ligation and retrograde injection for varicose veins.

2. A classification of anatomical end-results as (1) perfect, (2) good, and (3) failure is presented. Twenty-one and four tenths per cent were perfect, 60 per cent were good, and 18.5 per cent were failures; of the latter, almost half were probably avoidable.

3. The causes of failure are discussed.

4. The combination of high ligation and retrograde injection is a satisfactory and valuable method of treating marked varicosity of the saphenous system.

5. The treatment of varicose veins is still in a state of flux; only by late end-result studies can present day enthusiasms be evaluated.

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EDITORIALS

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FACTORS IN LOWERING MORTALITY IN THYROIDECTOMY FOR TOXIC GOITER

IT is agreed by all surgeons doing thyroid work that the mortality rate for thyroidectomy for thyrotoxicosis should be no greater than one per cent. However, there are perhaps numerous clinics where the mortality rate will be much higher than this. Occasionally this will be a matter of coincidence influenced by a small series. On other occasions it will be explained on the basis of lack of appreciation of the importance of prerequisites in thyroid surgery. It is a great advantage to the surgeon not to have iodine administered to the patient except during the two week interval previous to operation. Naturally, if iodine has been given for a period longer than three weeks, the optimum operability may have been lost.

Of the *prerequisites* for thyroidectomy, (1) administration of iodine for ten days to three weeks; (2) gain in weight; (3) lowering of metabolic rate to 50 or below; (4) pulse rate below 110; and (5) decrease in symptoms, are the most important. In patients who are exceedingly toxic, a ten day interval of iodine preparation will be insufficient; very commonly the patient's condition will improve remarkably for a period as long as three weeks following administration of Lugol's therapy. One of the most important prerequisites is that the patient must be gaining in weight when he is operated on. To attain this gain a daily intake of 4,000 or 5,000 calories may be necessary. Rarely is it justifiable to perform thyroidectomy in the absence of a gain in weight. Exceptions might be legitimate when the toxicity is relatively mild. The prerequisite of having the basal metabolic rate below 50 at the time of operation is naturally somewhat arbitrary, particularly since on numerous occasions the basal metabolic rate will not be an accurate estimation of the degree of toxicity. As a general rule, however, attempt should be made to get the patient's basal metabolic rate below 50 before considering operation. The prerequisite of having the resting pulse rate below 110, is likewise somewhat arbitrary but it is a well known fact, at least in the writer's opinion, that patients whose pulse rate at rest is over 110 are apt to have a serious reaction following thyroidectomy. Patients with a marked degree of toxicity should have a definite improvement in symptoms. With very few exceptions, Lugol's therapy will bring about this improvement.

There will be instances occasionally when the patient's toxicity is out of control, and the prerequisites listed cannot be met. The surgeon should not give up in desperation and

submit the patient to thyroidectomy until he has observed the patient and utilized such principles as bed rest, unusually high caloric intake, sedation, etc., in the hope that a regression will take place. Almost always there will come a time when the toxicity will be reduced sufficiently so that operation will be comparatively safe. In patients who are exceedingly toxic it may be wise to perform thyroidectomy only on one side. It is the writer's opinion that this procedure will save many lives. This opinion is held by Lahey and many others. The decision as to whether one or both lobes should be removed is much more important than the operating technique itself in this group of toxic patients. If the pulse rate rises above 140 during removal of the first lobe, in the absence of the interference by anesthetic factors, the question of performing a thyroidectomy only on one side should be taken into consideration by the surgeon and anesthetist.

In the operative technique such principles as leaving the posterior capsule, abstaining from applying clamps near the trachea, etc., will eliminate a certain number of complications such as nerve injury, tetany, etc. All vessels must be tied tightly. Undoubtedly, some instances of postoperative hemorrhage arise because of failure to tie a major vessel, but in other instances because the ligature became untied or was kicked off by a pulsating vessel. Large vessels such as the superior pole, should be tied doubly. The question of using silk or catgut is open to dispute, but the writer favors the use of silk because of the formation of less serum after operation, and because the postoperative course is slightly smoother. There is no question but that consideration of prerequisites such as those herein mentioned will diminish the operative mortality following thyroidectomy for thyrotoxicosis.

WARREN H. COLE.

ENDOMETRIOSIS

A CONDITION such as endometriosis which produces much disability and presents many difficult problems in treatment will continue to be a most interesting subject until its complex nature is understood more clearly. It is known that endometriosis is an abnormal growth of endometrial tissue in an ectopic position but it is not known exactly why some women are affected and not others. It is known too that 80 per cent of all patients seen who have endometriosis are between 30 and 50 years of age, that endometriosis becomes quiescent if the ovaries are removed surgically or their function destroyed by irradiation and that there is primary sterility in approximately 35 per cent of cases. It seems logical, therefore, to assume that in some women a factor exists which rigidly controls the endometrium in its normal position and causes it to become inactive when it is in an ectopic position. If this assumption were faulty, then all women should have more or less endometriosis since endometrial cells do find their way into the peritoneal cavity at some time. It has been shown to the satisfaction of most gynecologists and physiologists that the activity of the endometrium is regulated by the hormones of the ovary, estrogen and progesterone, which are in turn under the control of the gonadotropic hormone of the pituitary. Anything that disturbs this normally balanced equation could seriously disturb the metabolism of the normal endometrium. It may be possible that this mechanism is congenitally defective in varying degrees and that endometriosis, as well as menstrual disturbance, is a direct heritage.

A rather direct relationship has been noted between the degree of cystic hyperplasia of the endometrium and the extent of the endometriosis. If cystic hyperplasia of the endo-

metrium denotes ovarian dysfunction or failure, then when cystic hyperplasia grade 3 or 4 is present and is associated with endometriosis clinically, the endometriosis may be assumed to be too extensive for conservative surgical treatment. Also, if the endometrium is nearly normal and there is clinical evidence of pelvic endometriosis, the chances of avoiding radical surgical measures are much greater. If observation of such relationships should be confirmed sufficiently often, it may become possible to determine from biopsy of the endometrium whether the ovary and uterus are rapidly becoming functionless. If such a condition is encountered even though the patient is in the latter part of the third decade or early in the fourth decade, panhysterectomy is the procedure of choice. The power to reproduce is almost certainly gone and ability to bring about normal menses by substitution therapy is essentially nil.

An observation which may have considerable influence in clarifying this subject was made by Dockerty who noted that exactly the same histological picture of the menstrual cycle as seen in the endometrium of the uterus can be seen in practically all endometrial implants. For instance, if the endometrium is in the proliferative or differentiative stage, it will appear the same in the implants. This seems to indicate strongly that endometrial implants are derived in some way from normal endometrium and not from metaplasia of the cells of the peritoneum or cell rests of the wolffian or muellerian ducts. This is additional evidence that the ectopic endometrium is under the same controlling influence as normally situated endometrium.

When endometrial implants involve the ovary and hemorrhage occurs, hemorrhagic or chocolate cysts are initiated. The implant is easy to locate in a tiny cyst, but is often difficult to find in a large chocolate cyst, since most of the repeated hemorrhages may be from one or more implants in or near the fixed portion of the cysts. These cysts must be differentiated from the hemorrhagic cysts of the corpus luteum. The latter are smaller and do not contain evidence of multiple hemorrhages within a cavity. The term "chocolate cyst," I believe, should be used to denote cysts of endometrial origin in contradistinction to the hemorrhagic cysts of the corpus luteum. A further distinguishing feature of the chocolate cyst is the extent of irritation or reaction in structures adjacent to the cyst and also the one or two rigidly fixed points of the cyst wall. If these points are carefully investigated, the endometrial implant will be found there if not in any other position.

Diffuse external endometriosis is often lacking when large bilateral chocolate cysts are present, and I suspect that it is for this reason that many gynecologists maintain that the chocolate cyst is not endometrial in origin. It is my belief that the patient with large chocolate cysts often has fewer implants and, therefore, less dysmenorrhea than the patient with endometriosis and very small or no chocolate cysts. Furthermore, the former seeks treatment for menstrual disturbance, the latter, for dysmenorrhea and often sterility.

The situation, projection, and distribution of the pain produced by endometriosis should be studied carefully for the pain is the one most important symptom which induces the patient to consult the physician. Disturbances in the amount or character of the menstrual flow are usually of secondary importance except when associated with large chocolate cysts and are seldom of enough significance to constitute the patient's primary complaint. An analysis of the distinctive symptom, pain, frequently indicates certain features which aid in diagnosing the location and the extent of the disease. Rivers in his

analysis of pain produced by a lesion in the gastro-intestinal tract has shown that two types of pain exist depending on the location and extent of the lesion. He pointed out that as long as the lesion is confined to a portion of the bowel only, the pain is of visceral or sympathetic type and has no localizing symptoms, but if the lesion becomes penetrating or involves any adjacent tissue by inflammatory reaction, the pain becomes somatic or spinal sensory in type. The pain then is referred over the course and extent of the spinal sensory nerve which projects to a particular segment of the trunk and can be localized in that region. A typical example of this is noted in acute appendicitis. The pain at the onset is generalized or visceral in type but when the inflammation spreads to the local peritoneum the distress becomes severe and localized over the right lower quadrant as a somatic or spinal sensory pain.

The pelvic viscera and adjacent peritoneum should portray the same visceral and somatic type of pain as abdominal viscera. There seems to be sufficient evidence to support this view. The pain of primary dysmenorrhea is a pure visceral or sympathetic type of pain, since nothing is involved but the contracting uterine musculature and the pain is designated as uterine cramp. If dysmenorrhea has not existed previously but is acquired and if it becomes progressive, invasion of the uterine wall by endometrial tissue should be suspected. The pain then becomes a more prolonged visceral type of pain. However, it has been observed that if the endometrium is outside of the uterus itself, the pain is more likely to be of a different character. For example, endometrioma of the round ligament produces pain which is referred to the inguinal region whereas endometriomas situated under the broad ligament and along the ovarian ligament produce pain which is referred to the groin and inner side of the thigh. This pain is purely somatic in type, since the parietal peritoneum has become involved. Lesions of the rectosigmoid juncture cause distress which is referred to the anus and, when the endometrioma involves the mucous membrane of the rectum, there is a desire to defecate.

Finally, if strict attention is given to the extent of cystic hyperplasia of the endometrium and the type of pain produced by the endometrial lesions is analyzed carefully, it is possible to obtain a more accurate picture of the condition for consultation before treatment of any type is instituted.

VIRGIL S. COUNSELLER.

TEXTS AND DOCUMENTS

ARNO B. LUCKHARDT, M.D., Chicago, Illinois

THIS Journal proposes to print from time to time historical texts of an instructive and/or amusing character, the ensuing example being presumably of the latter type.

Most biographical articles are so written that the reader is left in a state of reverential awe for the subject of the biography, because of a sort of deification of his subject. We understand, of course, that the "hero" was born like other mortals but sense that it was on Mount Olympus with a hereditary halo of sanctity about him "*ab initio*." As human beings we usually look in vain for the mortal characteristics of the man or woman. If alluded to at all we usually find the worthy endowed with divine attributes acquired or developed to a high degree of perfection with the result that we visualize the hero walking through life not as a human being who lived and breathed like the rest of us but as one who of divine origin could not ever talk, live, and think, and act in a human or earthly manner.

It is therefore entertaining and refreshing to find an occasional account of a genius who walked this earth as a mortal and who had and contended with the same usual "*passiones animae*" (Descartes) that are characteristically human.

Such an account we discover in Aubrey's *William Harvey*. Of biographer Aubrey we know little except that he was apparently a genial and observant man, who remarks about himself: "My head was always working, never idle, and even travelling, 'did glean some observations some whereof are to be valued.'"

Aubrey's notes on the great Dr. William Harvey and other gentlemen were originally designed as memoranda for use of Anthony A. Wood when the latter was composing his "Athenae Oxonienses."

These notes never reached the hands of Anthony Wood or were neglected by him: for the "Athenae Oxonienses" as published contains no biographical notice of William Harvey—undoubtedly the most illustrious of the favorite sons of Oxford.

The notes of Aubrey were found years later in the Bodleian Library and Ashmolean Museum and published by the printers under Aubrey's name with the title:—"Letters written by Eminent Persons in the 17th and 18th Centuries. To which are added, Hearne's Journeys to Reading and to Whaddon Hall, the Seat of Browne Willis, Esq. and Lives of Eminent Men by John Aubrey, Esq. Printed for Longman, Hurst, Rees, Orme, and Brown, Paternoster Row; and Munday and Slatter, Oxford, 1813."

In the advertisement at the beginning of the first volume the publishers state that Aubrey's notes "are now submitted to the public as literary curiosities" and that "some passages, either too trifling, or too gross, for publication, are omitted." (Sic.)

The present author found a complete reproduction of Aubrey's Memoirs of Dr. Harvey in the Eclectic Repertory and Analytical Review, Medical and Philosophical, VI, 1816, pp. 107–113 inclusive. The editors of the Eclectic Repertory had in turn taken it from *The London Medical and Physical Journal*. Neither periodical credits it to Aubrey who according to Leake[1] was Harvey's first biographer.

Many biographers of Harvey quote snatches of Aubrey usually without crediting the author.

The ensuing reproduction was made from the Eclectic Repertory which was compared carefully with the original Aubrey letters as noted above, Vol. II, Part II, London 1813, pp. 376–386. This transcription from the Repertory is exact in wording but not in spelling, italicization, and punctuation except that the Repertory omitted the passage in brackets [] which I have copied from Aubrey and which I have never seen reproduced.

It should be borne in mind that the following account of Harvey by Aubrey is authentic since Aubrey knew Harvey, in fact was one of the great physician's pallbearers as he plainly states in the text which follows herewith:—

Physiological Laboratory, The University of Chicago.

[1] C. D. Leake. Anatomical Studies on the Motion of the Heart and Blood. By Wm. Harvey. C. C. Thomas, 1931 (Appendix I), p. 141.

MEMOIRS OF THE CELEBRATED DR. HARVEY

From Notes Collected from the Bodleian Library and Ashmolean Museum

(Letters written by Eminent Persons in the 17th and 18th centuries; To which are added, Hearne's Journeys to Reading, and to Whaddon Hall, The Seat of Browne Willis, Esq. and Lives of Eminent Men, by John Aubrey, esq.—The whole now first published from the Originals in The Bodleian Library and Ashmolean Museum, with Biographical and Literary Illustrations.—In two volumes, Vol. 1, London. Printed for Longman, Hurst, Rees, Orme, and Brown, Paternoster-Row; and Munday and Slatter, Oxford, 1813.)

GUL. HARVEUS, An.aetat. 10, in Schola Cantuar; primis doctrinae rudimentis imbutus; 14. Col. Gonvil. et Caii Alumnus; 19, peragravit Galliam et Italiam; 23, Patavii Praeceptores habuit Eust. Radium, Tho. Minad. H. Fab. ab Aquapend. Consul Angl. 16* fit; 24, Doctor Med. et Chirurg. Reversus Lond. praxin exercuit, et uxorem** duxit; 25, Coll. Med. Socius; 37, Anatom. et Chirurg. Professor; 54, Medicus Regius factus. Scripsit de Motu Sanguinis, et de Gen. Animal. Obiit 30 Jun. MD. CLVII. Aetat. 80§ (But I well remember that Dr. Alsop, at his funeral sayd, that he was eighty wanting one; and that he was the eldest of nine brethren.)

He lies buried in a vault at Hempsted in Essex, wch. his brother Eliab Harvey built, he is lapt in lead, and on his brest in great letters Dr. William Harvey. I was at his funerall, and helpt to carry him into the vault.

In the library at the Physitians' Colledge, was the following inscription above his statue, (which was in his doctorall robes.)

Gul. Harveus, Natus A. D. 1578, Apr. 2. Folkston,† in Com. Gantii, Primogenitus Tho. Harvei et Joanae Halk. Frat. Germani. Tho. Jo. Dan. Eliab. Mich. Mat. Sorores. Sarah, Amey.

Under his white marble statue, on the pedestall, thus,

GULIELMO HARVEO,
Vivo,
Monumentis suis immortalli,
Hoc insuper
Coll. Med. Lond.
Posuit
Qui enim Sanguinis Motum
(ut et animal ortum) dedit
meruit esse
Stator Perpetuus.

*Sic. Edit.
**Smyth.
§Over Dr. Harvey's picture in the great parlour under the library, at the Physitians' College at Amen-corner, (burnt.)

Dr. Harvey added (or was very bountiful in contributing to) a noble building of Roman architecture (of rustique work with Corinthian pillasters) at the Physitians' College aforesaid, viz. a great parlour, a kind of convocation-house for the fellows to meet in belowe; and a library above. On the outside, on the freeze, in letters three inches long, is this inscription, SUASU ET CURA FRAN. PRUJEANI, PRAESIDIS, ET EDMUNDI SMITH, ELECT. INCHOATA ET PERFECTA EST HAEC FABRICA. AN. MIDCLIII.

All these buildings and remembrances were destroyed by the generall fire.

He was always very contemplative, and the first yt. I heare of yt. was curious in Anatomie in England. He had made dissections of froggs, toads, and a number of other animals, and had curious observations on them, which papers, together with his goods, in his lodgings at Whitehall, were plundered at the beginning of the rebellion, he being for the king, and with him at Oxon; but he often sayd, that of all the losses he sustained, no griefe was so crucifying to him as the losse of these papers, wch. for love or money he could never retrieve or obtaine. When K. Ch. I. by reason of the tumults left Lond, he attended him and was at the fight of Edge-hill with him; and during the fight, the Prince and D. of Yorke were committed to his care. He told me that he withdrew with them under a hedge, and tooke out of his pockett a booke and read; but he had not read very long before a bullet of a great gun grazed on the ground neare him, which made him remove his station; he told me yt. Sir Adrian Scrope was dangerously wounded there, and left for dead amongst the dead men, stript, which happened to be the saving of his life. It was cold clear weather, and a frost that night; which staunched his bleeding, and about midnight, or some hours after his hurt, he awaked, and was faine to drawe a dead body upon him for warmeth sake.

After Oxford was surrendered, which was 24 July, 1646, he came to London, and lived with his brother Eliab, a rich merchant in London, on ——— hill, opposit to St. Lawrence, Poultry,

†Born in the house which is now the post house, a fair stone built house, which he gave to Caius Coll. in Cambridge, with some lands there, in his will. His brother Eliab would have given any money or exchange for it, because 'twas his father's and they all borne there, but the doctor (truly) thought his memory would be better preserved this way, for his brother has left noble seats, and about 3000 pounds per annum at least.

where was then a high leaden steeple, (there were but two, viz. this and St. Dunstan's in the east,) and at his brother's country house at Roehampton. His brother Eliab bought, about 1654, Cockaine-house, now (1680) the Excise Office, a noble house, and had his severall stations, in regard of the sun, or wind. He did delight to be in the darke, and told me he could then best contemplate.

He had a house heretofore at Combe, in Surrey, a good air and prospect, where he had caves made in the earth, in which in the summer time he delighted to meditate. He was pretty well versed in mathematiques, and had made himselfe master of Mr. Oughtred's Clavis Math. in his old age; and I have seen him perusing it, and working problems not long before he dyed, and that book was always in his meditating apartment. His chamber was that room which is now the office of Elias Ashmole, esq. where he dyed, being taken with the dead palsey, which took away his speech; as soon as he was attaqued, he presently sent for his brother and nephews, and gave one a watch, another another thing, &c. as remembrances of him. He dyed worth 20,000 pounds, wch. he left to his brother Eliab. In his will, he left his old friend, Mr. Tho. Hobbes, 10 pounds, as a token of his love.

He was wont to say, that man was but a great mischievous baboon.

He would say, that the Europeans knew not how to order or govern our woemen, and that the Turks were the only people (who) used them wisely.

He had been physitian to the Lord Ch. Bacon, whom he esteemed much for his witt and style, but would not allow him to be a great philosopher, Said he to me, "He writes philosophy like a Ld. Chancellor," speaking derision.*

About 1649, he travelled again into Italy, Dr. George, now Sir George Ent, then accompanying him.

At Oxford he grew acquainted with Dr. Charles Scarborough, then a young physitian, (since by Ch. II. knighted) in whose conversation he much delighted; and whereas before, he marched up and downe with the army, he took him to him and made him ly in his chamber, and said to him, "Prithee leave off thy gunning, and stay here, I will bring thee into practice." . . . . ["I remember he kept a pretty young wench to wayte on him wch. I guesse he made use of for warmth's sake, and tooke care of her in his will, as also of his man servant."] (This passage occurs in Aubrey's account and is the only passage omitted in the reprint which does not even credit Aubrey with having written the entire biography. The account appears in vol. II, Part II, p. 381 of Aubrey's book.) For twenty years before he dyed, he took no manner of care about his worldly concerns, but his brother Eliab, who was a very wise and prudent manager, ordered all not only faithfully, but better than he could have done for himselfe. He was, as all the rest of the brothers, very cholerique, and in his younger days wore a dagger (as the fashion then was, nay I remember my old schoolmaster, Mr. Latimer, at seventy, wore a dudgeon, with a knife and bodkin, as also my old grandfather, Lyte, and alderman Whitson, of Bristowe, wch. I suppose was the common fashion in their young dayes,) but this Dr. would be apt to drawe out his dagger upon every slight occasion.

He was not tall, but of the lowest stature, round faced, olivaster (like wainscott) complexion; little eie, round, very black full of spirit; his haire was black as a raven, but quite white twenty years before he dyed.

I first sawe him at Oxford, 1642, after Edgehill fight, but was then too young to acquainted with so great a doctor. I remember he came severall times to our Coll. (Trin.) to George Bathurst, B. D. who had a hen to hatch egges in his chamber, which they dayly opened to see the progress and way of generation. I had not the honour to be acquainted (with) him till 1651, being my cos. Montague's physitian and friend. I was at that time bound for Italy, (but to my great grief dissuaded by my mother's importunity.) He was very communicative and willing to instruct any that were modest and respectfull to him. And in order to my journey, dictated to me what to see, what company to keep, what bookes to read, how to manage my studyes; in short, he bid me go to the fountaine head, and read Aristotle, Cicero, Avicenna, and did call the neoteriques s . . t breeches. He wrote a very bad hand, which with use I could pretty well read. I have heard him say, that after his booke of the Circulation of the Blood came out, he fell mightily in his practice, and 'twas believed by the vulgar, that he was crack-brained; and all the physitians were against his opinion, and envyed him; with much adoe at last in about twenty or thirty yeares time, it was received in all the universities in the world, and, as Mr. Hobbes sayes in his book, "De Corpore," *he is the only man, perhaps, that ever lived to see his owne doctrine established in his life-time.*

*This must relate to Bacon's physiological opinions as exemplified in his *Historia Vitae & Mortis*, the work which produced so much wit in the Tristram Shandy, concerning radical heat and radical moisture. Harvey's mode of inquiry was exactly such as Bacon pointed out in his Nov. Organum. But it must be admitted, that Bacon's only physiological work savours much of precedents, in the Lord Chancellor style.—Edit.

He understood Greek and Latin pretty well, but was no critique, and he wrote very bad Latin. The Circuitus Sanguinis was, as I take it, donne into Latin by Sir George Ent, as also his booke de Generatione Animalium, but a little booke in 12mo. against Riolan (I thinke) wherein he makes out his doctrine clearer, was writt by himselfe, and that, as I take it, at Oxford.

His Maj. K. Cha. I. gave him the wardenship of Merton Colledge, as a reward for his service, but the times suffered him not to receive or enjoy any benefit by it.

He was physitian and a great favourite of the Lord High Marshall of England, Tho. Howard, Earl of Arundel and Surrey, with whom he travelled as his physitian in his ambassade to the Emperor ———, at Vienna, Ao. Dni. 163–. Mr. Hollar (who was then one of his excellencie's gentlemen) told me, that in his voyage, he would still be making of excursions into the woods, making observations of strange trees and plants, earths, &c. and sometimes like to be lost. So that my Lord Ambassador would be really angry with him, for there was not only danger of thieves but also of wild beasts.

He was much and often troubled with the gowte, and his way of cure was thus: he would then sitt with his legges bare, if it were frost, on the leads of Cockaine-house, putt them into a payle of water, till he was almost dead with cold, and betake himselfe to his stove, and so 'twas gone.

He was hott headed, and his thoughts working would many times keep him from sleeping: he told me, that then his way was, to rise out of his bed and walke about his chamber in his shirt, till he was pretty coole, i.e. till he began to have a horror, and then returne to his bed, and sleep very comfortably. I remember he was wont to drinke coffee, which he and his brother Eliab did, before coffee-houses were in fashion in London.

All his profession would allowe him to be an excellent anatomist, but I never heard any that admired his therapeutique-way. I knew several practitioners in this towne (London) that would not have given 3d for one of his bills; and that a man could hardly tell by one of his bills, what he did aime at.

He did not care for chymistrey, and was wont to speak against them,* with undervalue.

It is now fitt, and but just, that I should endeavour to undeceive the world in a scandall, that I find strongly runnes of him, wch. I have mett amongst some learned young men: viz. that he made himselfe away, to putt himselfe out of his paine, by opium; not but that, had he laboured under great paines, he had been readie enough to have donne it, I doe not deny, that it was not according to his principles upon certain occasions to ————, but the manner of his dyeing was really and bona fide thus, viz. the morning of his death, about ten o'clock, he went to speake, and found he had the dead palsey in his tongue, then he sawe what was to become of him, he knew there was then no hopes of his recovery, so presently sends for his young nephews to come up to him to whom he gives one his watch,** to another another remembrance, &c. made sign to ———— Sambroke, his apothecary, in Black-fryars, to lett him blood in the tongue, which did little or no good, and so he ended his dayes. His practice was not very great towards his latter end, he declined it, unlesse to a speciall friend, ——e.g. my Lady Howland, who had a cancer in her breast, which he did cut off and seared, but at last she dyed of it.

He rode on horseback with a foot-cloath to visitt his patients, his man following on foot, as the fashion then was, wch. was very decent, now quite discontinued. The judges rode also with their foot-cloathes to Westminster hall, wch. ended at the death of Sir Rob. Hyde, Lord Ch. Justice. Anth. E. of Shaft. would have revived (it,) but several of the judges being old and ill horsemen would not agree to it. The scandal aforesaid is from Sir Charles Scarborough's sayings that he had, towards his latter end, a preparation of opium, and I know not what, which he kept in his study to take, if occasion should serve, to putt him out of his paine, and which Sir Charles promised to give him: this I believe to be true; but do not at all believe that he really did give it him. The palsey did give him an easie passeport.

*Sic. Edit.
**'Twas a minute watch, wth. wch. he made his experiments.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE recent volume of 257 pages by Jean Oliver entitled *Architecture of the Kidney in Chronic Bright's Disease*[1] is beautifully printed and illustrated on a semi-gloss paper. The work is well seasoned because of the author's long collaboration with the renal student, Dr. Thomas Addis. The first plate is a microdissection of a lobule of the normal adult kidney and the next 8 pages are given to a discussion of the methods and technique used in preparing the material.

The following chapter presents new and detailed measurements of the unit of renal function which show that proximal tubule "hypertrophy" may result in doubling the length of this portion and increasing its volume by 5, so that a single hypertrophied proximal tubule may "equal in size or, in the diseased organ, take the place of ten normal units." Atrophy of the rest of the unit is variable. Capacity of function may be compared with this combined atrophy and hypertrophy. However, evidence is presented which shows that in terminal Bright's disease the blood supply is shunted around the glomerulus to the constantly developing proximal convoluted tubules, and that these tubules have the ability "to take over the function of the destroyed glomeruli." With regard to these proximal tubules "even when they themselves are at last disrupted, their remaining portions persist and maintain structural characteristics that present evidence of progressive growth and active vitality." Further work is needed to evaluate these important observations. The suggested specific function of various parts of the tubule indicated by Dr. Oliver's work should offer a fertile field because of the increasing clinical evidence of specific mineral metabolic factors which so greatly alter the clinical and therapeutic problems met by the physician. The author's dissections and models demonstrate the difficulty and often misleading appearance of the end-stage cystic tubule residuals brought about by scar tissue and collagenous material when studied by the ordinary microscopic section.

This volume stands not only as a compliment to Dr. Oliver but is a tribute also to patience and to research by new methods into the field of pathological physiology which are so urgently needed.

M. HERBERT BARKER.

THE author has correlated an enormous mass of material in *Operative Orthopedics*[2] that would require a great deal of time and effort on the part of the individual doctor. Campbell has shown conservatism and mature judgment; he knows what to expect from non-operative treatment and appreciates the virtues and limitations of conservative care. The selection of material, its assembly, and composition are highly recommended.

He discusses the physiology and pathological changes that occur in bones and joints and their related structures. His chapters on surgical technique and surgical approaches are among the highlights of the book; his discussions of pyogenic and arthritic infections and osteomyelitis are well done.

The sections on congenital anomalies, static and postural defects, neurological affections, and disturbances of muscles, tendons, and bursæ are well worth reading. There is also a section on arthrodesing operations.

I have, however, left 3 of the outstanding sections for the last, viz., arthroplasty, traumatic conditions, and tumors. The author is a pioneer in the subject of arthroplasty and much of his work is standard. His contributions to the subjects of internal fixation, the treatment of malunion and non-union of fractures are generally accepted. Campbell's relatively vast experience in bone tumors makes his contribution worthy of serious consideration. He has always co-operated with the Bone Tumor Registry of the American College of Surgeons.

The cost of the book is more than balanced by its value. It marks a real advance. The author accomplished what he started out to do. It is a big job well done, and could be accomplished only with a full time staff such as Campbell has, including Speed, Boyd, and Smith medically and Ingram and Summers artistically.

The publishers of books of this type should be encouraged.

PHILIP LEWIN.

IN a 236 page monograph entitled *Peripheral Vascular Diseases*,[3] Collens and Wilensky cover briefly the present day knowledge of the signs and symptoms and the treatment of the commoner peripheral arterial disturbances as arteriosclerosis, thromboangiitis obliterans, and Raynaud's syndrome. It is a well written book as far as it goes; but unfortunately the authors mention the less common peripheral arterial disturbances only very briefly, and such important subjects as arterial aneurisms and arteriovenous fistulas are not discussed. The venous and lymphatic disturbances of the extremities are not mentioned.

[1] ARCHITECTURE OF THE KIDNEY IN CHRONIC BRIGHT'S DISEASE. By Jean Oliver. New York and London: Paul B. Hoeber, Inc., 1939.

[2] OPERATIVE ORTHOPEDICS. By Willis C. Campbell, M.D. St. Louis: The C. V. Mosby Co., 1939.

[3] PERIPHERAL VASCULAR DISEASES; DIAGNOSIS AND TREATMENT. By William S. Collens, B.S., M.D., and Nathan D. Wilensky, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1939.

The book is divided into 2 parts: anatomy and physiology. Diagnosis is discussed in the first part and treatment in the second part of the book. The various diagnostic signs and symptoms are described very clearly, but the physiological interpretation of some of the diagnostic tests is not discussed adequately. All the known therapeutic measures used for peripheral arterial disturbances are described. The book is easy to read and should be a help to those unacquainted with peripheral arterial disturbances.

SAMUEL PERLOW.

THE sixth edition of Paluel J. Flagg's *Art of Anesthesia*,[1] is a 480 page, amply illustrated, well bound volume. The book has been changed from its previous editions in many ways. Chapters devoted to cyclopropane and to the carbon dioxide technique, and discussions including divinyl ether, helium, and the art of laryngoscopy and intubation help to bring the volume up to date.

The author presents a fairly comprehensive survey of the subject and includes the classification, characteristic signs, and technique of administration of the various commonly used and newer anesthetic agents. Subjects which are intimately associated with or which may be considered a part of anesthesiology, such as oxygen therapy, or the physiological and theoretical basis of anesthesia, are not discussed.

There are discrepancies in the paging of the index tabulation, and references to various pages in the book are incorrect. Apparently these have not been changed from the previous edition.

It is noted that though much of the material is elementary, there is a practical aspect to the book which only a man who has given many years to the specialty could convey.

MARY KARP.

THE grouping of all sclerosing therapy in one volume is a good idea, for in a sense it is all similar; and this new book, *Sclerosing Therapy*,[2] fills a real place on the shelf of any physician who is at all interested in the treatment of these conditions.

The section on the injection treatment of hernia is by far the best and most thorough part of the work. Dr. Bratrud has covered it well and in detail, and yet it is not too verbose. The anatomical drawings and charts show the anatomy so clearly that with study any physician should clearly understand just what the author is trying to do. This together with the chapter on technique makes the work appear very simple indeed. He believes the proper fitting and wearing of the truss is the most important single point in the successful treatment of hernia. The pathological studies are very thorough and clearly show the results of the injections, which seem to be conclusive of the good results to be obtained. The subject of solutions used is well covered and the author leaves no doubt as to just what he thinks about each solution. He clearly states that he prefers the proliferol T special for the usual case.

The chapter on the injection treatment of hydrocele is concise and yet the subject is well covered. Dr. Hock has made it simple but has emphasized the important points of care and attention to details. He prefers the use of quinine preparations for this work. However, he did not sufficiently emphasize the importance of the tight, all elastic suspensory for the first few days immediately following the treatment.

Part 3 is devoted to the treatment of varicose veins. The same space is given this subject as is allotted the treatment of hernia. The subject is well covered and takes up all phases. Dr. Shelly has made a most thorough review of the literature and has followed a happy middle ground throughout the work. He is conservative and yet thorough. The chapter on preliminary ligation is good, the drawings are above the average, and his reference index is very complete.

There are 50 pages on the injection treatment of hemorrhoids. The author makes a plea for the injection of only internal uncomplicated hemorrhoids. The anatomy and embryology are briefly but adequately outlined. These must be understood before injection therapy is used. The author states that 50 per cent of cases seen represent uncomplicated internal hemorrhoids which are suitable for either injection or surgery. This figure is high for those cases which are suitable for injection alone.

Solutions containing phenol are preferred and of course only internal hemorrhoids can be injected. The exact technique, solutions used and recommended are discussed. Recurrence is more common after injection than following surgery.

The subject is well outlined and covered and anyone interested in the injection treatment of hemorrhoids cannot but be aided by reading and studying this article.

H. O. MCPHEETERS.

THE collection of lectures by Leriche, entitled *The Surgery of Pain*,[3] is an exposition of the author's conception of pain gathered from the study of pain in the clinic, that is, "living pain." But little attempt is made to explain the physiology of pain by experiment or accepted theories, and the author seldom feels called upon to justify his ideas in the light of such theories. Actually, the book is a monument to an "idée fixe," since it deals principally with the surgery of the sympathetic nervous system and the clinical relationship of these nerves to pain, which has long been a professional love of the author.

As pointed out by the translator, many of the views set forth are revolutionary; many are entirely unaccepted by today's physiologists. But after reading the book, one cannot but be impressed by its frankness, by the author's honesty and sincerity,

[1] THE ART OF ANESTHESIA. By Paluel J. Flagg, M.D. 6th rev. ed. Philadelphia, London, Montreal: J. B. Lippincott Co., 1939.

[2] SCLEROSING THERAPY; THE INJECTION TREATMENT OF HERNIA, HYDROCELE, VARICOSE VEINS AND HEMORRHOIDS. Edited by Frank C. Yeomans, M.D., F.A.C.S., M.R.S.M.(London, Hon.). Baltimore: The Williams & Wilkins Co., 1939.

[3] THE SURGERY OF PAIN. By René Leriche, M.D.(Lyon), LL.D. (Glasgow), F.R.C.S.(Eng.). Translated and edited by Archibald Young, B.Sc., M.B., C.M., F.R.F.P.S.G., F.A.C.S.(Hon.), M.D.(Strasbourg) Baltimore: The Williams & Wilkins Co., 1939.

and by his ready admission of certain failures. Agreeing or not with the many bold statements, the reader must admit that the book is provocative of thought, that its logic is generally good, and that there must be some merit in the methods which have produced favorable results in such a large number of patients. The style is free, informal, almost conversational at times; aphorisms are to be found, and, unfortunately, the author in places becomes platitudinous. For a translated work, it seems apparent that the original style has been unusually well preserved and brought over into English.

The book is over 500 pages long and deals with practically every sort of pain. Facial neuralgia, causalgia, the pains of amputation stumps, nerve injuries, and various vasoconstrictive diseases, the pain of angina pectoris, and several other pain entities are considered. Most of these subjects are covered with a discussion of existing theories as to cause, the experimental data at hand (which is often incomplete) the rôle of the sympathetic nervous system, the operative attack, and a minimum of illustrative case reports. To Leriche there are 2 general kinds of pain: the pain of the cerebrospinal type, fixed, localized, and anatomical in limit; and the pain of the sympathetic type, diffuse, spreading, vague, and closely related to emotional states. A purely sympathetic pain may be controlled by the proper measures aimed directly at the sympathetics; also, the cerebrospinal type of pain may in many instances be cured or alleviated by novocainization or ablation of the appropriate sympathetic ganglion.

The chapter on trigeminal neuralgia is particularly stimulating. Leriche defies anyone to show that arteriosclerosis, hypertension, diabetes, arterial compression of the root (Dandy), or other simple mechanical devices are the actual causes of this pain syndrome. His experiences with it have been much the same as those of other large clinics. Like most investigators, he is at a loss to name its cause; like most neurological surgeons he prefers to section the root by way of a subtemporal approach; and, as many others, he sees postoperative facial weakness, keratitis, and facial vesicular eruptions in some of his patients.

Leriche is very definite in the application of his beliefs regarding visceral pain to the surgical treatment thereof. He believes visceral pain to be an actual fact. He is impressed by the individual data furnished by François Franck, Kiss, and Collin, and he frankly disbelieves the theories explanatory of referred pain propounded by Mackenzie. He has treated 27 cases of angina pectoris surgically with generally satisfactory results. His aim is (1) to interrupt the initial vasoconstrictor reflex, (2) to establish a regimen of coronary vasodilatation, and (3) to reduce cardiac activity. To do this he excises or infiltrates with novocain the left stellate ganglion, a procedure which he holds to be anatomically correct.

The uses of periarterial sympathectomy, ganglion excision, ganglion novocainization, presacral neurectomy, etc., if not entirely original with Leriche, certainly find in him a leading exponent. The investigation of pain has been to him a hobby. Discontent with the use of "makeshifts" in the treatment of pain, he is sincerely satisfied with the effectiveness of his sympathetic surgery, though he admits it is no panacea; and he will remain firm in his trust in it as long as his clinical results justify such a stand, in spite of the thunder of all the physiologists in disagreement. JOHN MARTIN.

DR. HAUSER'S *Diseases of the Foot*[1] is not a book on acquired deformities and strains of the foot, but is a broad treatise of 472 pages which attempts to cover most of the known conditions which affect human feet. There is a short description of the anatomy and physiology of the foot, followed by chapters on shoes, hygiene, and general care of the feet with instructions for correct walking and standing. This is followed by a chapter on various types of flat feet with the treatment which the author recommends and includes the types of arch supports which he prefers. This is followed by acquired and congenital deformities of the toes with descriptions of the surgical operations which are usually used to correct them. There is a good chapter on accessory tarsal bones and another on circulatory disturbances of the foot and ankle.

Included in the book are chapters of various sprains of the foot and ankle, on fractures and dislocations of various bones of the foot and ankle, and on diseases of the nerves of the foot. The book also includes a chapter on the usual deformities of the foot which occur as a result of poliomyelitis and on congenital club foot. The various skin diseases which may affect the foot are also described and the accepted form of treatment for each is recommended.

Finally, there is a section which deals with the changes in the foot due to chronic arthritis.

On the whole, this is a book which will appeal to the man in general practice rather than to the specialist, because it covers such a wide field that no single subject can be treated exhaustively. However, I think that it fills a definite need and is a book which can be recommended to those who wish information on diseases, injuries, or deformities of the foot. Its value is accentuated by references to the literature which are placed at the end of each of the 30 chapters. J. ALBERT KEY.

[1] DISEASES OF THE FOOT. By Emil D. W. Hauser, M.S., M.D. With a foreword by Sumner L. Koch, M.D. Philadelphia and London: W. B. Saunders Co., 1939.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

ORTHOPEDIC OPERATIONS; INDICATIONS, TECHNIQUE, AND END RESULTS. By Arthur Steindler, M.D., F.A.C.S. Springfield, Ill., Baltimore, Md.: Charles C. Thomas, 1940.

MANUAL OF CARDIOLOGY; CLINICAL METHODS AND CASE HISTORIES AS PROBLEMS FOR STUDY. By William Duncan Reid, A.B., M.D., F.A.C.P. London, New York, and Toronto: Oxford University Press, 1940.

REPORTS ON MEDICAL PROGRESS, 1939; AS PUBLISHED IN THE NEW ENGLAND JOURNAL OF MEDICINE. Compiled and Edited by Robert N. Nye, M.D. Boston: Little, Brown & Co., 1940.

HEIL HUNGER! HEALTH UNDER HITLER. By Dr. Martin Gumpert. Translated from the German by Maurice Samuel. New York and Toronto: Alliance Book Corp.; Longmans, Green & Co., 1940.

ATLAS OF SURGICAL OPERATIONS. By Elliott C. Cutler and Robert Zollinger. Illustrated by Mildred B. Codding. New York: The Macmillan Co., 1939.

INJURIES OF THE SKULL, BRAIN AND SPINAL CORD; NEURO-PSYCHIATRIC, SURGICAL, AND MEDICO-LEGAL ASPECTS. Edited by Samuel Brock. A William Wood Book. Baltimore: The Williams & Wilkins Co., 1940.

SHOCK; BLOOD STUDIES AS A GUIDE TO THERAPY. By John Scudder, M.D., Med.Sc.D., F.A.C.S. Philadelphia, Montreal, London: J. B. Lippincott Co., 1940.

THE MANAGEMENT OF OBSTETRIC DIFFICULTIES. By Paul Titus, M.D. 2d ed. St. Louis: The C. V. Mosby Co., 1940.

A TEXTBOOK OF SURGERY. By John Homans, M.D. 5th ed. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1940.

CORRESPONDENCE

RE-ESTABLISHMENT OF GASTRO-INTESTINAL PASSAGE AFTER GASTRIC RESECTION

To the Editor:

In the issue of SURGERY, GYNECOLOGY AND OBSTETRICS for February 15, 1940, in an excellent article by Professor Pólya entitled "Re-Establishment of the Gastro-Intestinal Passage after Gastric Resection," an inaccuracy appears which it might be well to correct in order to keep the record straight.

On page 272 Professor Pólya is good enough to mention the operation that I have been doing for partial gastrectomy. The drawing of Figure 1, d, is not clear, but in the text it says "d, anterior end-to-side duodenogastrostomy, a modification of the former operation—implantation of the duodenal stump into the anterior wall of the stomach." As a matter of fact, this partial gastrectomy to which he refers is an end-to-end union of the duodenum, after flaring it open, to the stump of the stomach, preserving the relationship of the lesser curvature of the stomach to the upper border of the duodenum.

Anatomically I would think it would be impossible to implant the duodenal stump into the *anterior* wall of the stomach.

J. SHELTON HORSLEY.